Rotational Viscometer

Instruction Manual

VISCOLEAD SERIES

ADVANCE

Fungilab

Leading Viscosity Technology

VISCOLEAD SERIES
ADVANCE
Rotational Viscometer

Software Version: 5.2
Manual Version:1.3

Instruction Manual

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1. Introduction

Thank you for acquiring the ADVANCE rotational viscometer model from Fungilab.

The ADVANCE is a rotational viscometer, based on the torque measurement of a rotating spindle in the sample at a specified velocity. Three different models (type L, R and H), as well as various accessories, allow it to cover a wide range of viscosity measurement.

2. Safety Instructions

- It is not the purpose of this manual to outline all of the safety instructions recommended for the use of the rotational viscometer, its accessories and samples. It is the user's responsibility to establish health and safety practices and to determine the application's limits before use.

- Fungilab guarantees the satisfactory operation of the viscometers and its accessories if there has not been any unauthorized adjustment to the mechanical pieces, the electronic components and the software.

- The operator should follow all the instructions and warnings of this manual to ensure the safe and proper operation of the equipment.

- Do not use the equipment for any other purpose than those described in this manual.

- Do not use any accessory that is not supplied or approved by Fungilab.

- Do not use the viscometer or its accessories if there is any suspicion of malfunction. Do not use the equipment in situations or conditions that can cause personal injuries or material damage.

The rotational viscometer is **not a flameproof or an intrinsically safe (ATEX)** instrument. Therefore, it should not be used in areas where there is an explosion risk.

Before using the viscometer, read and observe carefully the following precautions:

Not following these instructions may cause serious harm or personal injuries.

To avoid an electric shock:

- The socket by which the viscometer will be connected should have a ground. Verify that the voltage and the frequency match with the specifications of the power supply. Before switching on the equipment, let it sit for some time so that it acclimates to the surrounding temperature in order to avoid a short-circuit caused by condensation. The fluctuations of the power source should not surpass ±10 % of the nominal voltage.

3. Safety Symbols and Precautions

Safety Symbols: The following symbols are used in this instruction manual:

This symbol warns of an operational, practical, or similar procedure that, if it is not carried out properly, may damage the equipment

This symbol indicates hazardous voltages may be present

This symbol indicates that additional information has to be considered

Precautions

If this instrument is used in a not specified by the manufacturer manner, the protection provided by the instrument may be impaired.

This instrument is not intended for use in a potentially hazardous environment.

In case of emergency, switch off the instrument and, after that, disconnect the electrical cord from the wall outlet.

The user should ensure that the substances placed under test do not release poisonous, toxic or flammable gases at the temperatures which they are subjected to during testing.

4. Utilities

Input Voltage:	Universal Power Supply (100-240V)
Input Frequency:	50 / 60 Hz
Power Consumption:	15 VA

Main supply voltage fluctuations cannot exceed ±10% of the nominal supply voltage

5. Specifications

Speeds:	0.3 – 100 RPM
Viscosity Accuracy:	±1.0 % of full scale range The use of accessory items will have an effect on the measurement accuracy
Viscosity Repeatability:	±0.2 % of full scale range
Temperature Accuracy:	±0.1 °C | -40 °C to 300 °C (-40 °F to 572 °F)
Operating Environment:	+5 °C to 40 °C temperature range (41 °F to 104 °F) Non condensing humidity

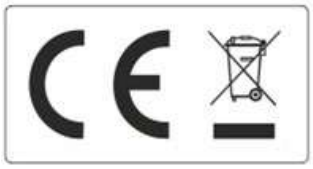
Noise emitted: Set less than 70 dB (A)
Vibrations emitted: Less than 2.5 m/s²

Certifications:

Conforms to CE Standards:

EN 61010-1:2010	Safety requirements for electrical equipment, for measurement, control and laboratory use.
EN 61326-1:2013	Electrical equipment for measurement, control and laboratory use
Directive RoHS:	2011/65/UE + 2014/IUE a 2014/6/UE +2014/8/UE a 2014/16/UE

Notice to customers:



The product is made up of various components and various materials that must be recycled or, failing that, deposited in the corresponding debris removal sites when the product's life has been completed or when otherwise it is necessary to dispose of it. To do this, the end user who acquires the product must know the current regulations of each municipality and / or locality based on the waste electrical and electronic equipment. The user who acquires this product must be aware of and responsible for the potential effects of the components on the environment and human health as a result of the presence of hazardous substances. Never place the product in a conventional container of citizen scope if a previous dismantling and knowledge of the components that incorporates. If you do not know the procedure to follow, consult with the city council for more information.

6. Conditions for use

- Indoor use
- Maximum altitude 2000 m.
- Surrounding temperature range: from +5 to 40ºC.
- The equipment temperature must be kept above the dew point so moisture doesn't condense on or in it. The power source fluctuations should not surpass ±10% of the nominal voltage
- Installation category II
- Pollution level II

7. Maintenance

- Always clean all of the parts after each use! Clean and dry the spindles and the spindle guard well. Make sure that there is not any sample remaining, especially in the delicate zones such as the spindle connector.
- Use detergents or solvents to clean the spindles and the protector:
    - For cleaning food samples, use lukewarm water and if necessary, use soft household detergents
    - Other solvents that generally provide good results are acetone, gasoline, or any solvent with a high percentage of alcohol
    - For the use of any other solvent, make sure that it does not corrode the spindles or the protector. The spindles are made in AISI 316.

Warning: Handle the volatile and flammable solvents with proper cautions. It is the user's responsibility to establish safety conditions at work.

- Check regularly the spindle's thread and the viscometer shaft.
- During the viscometer's lifespan, regular maintenance is important. FUNGILAB recommends annual check-ups by the technical service of your local distributor.

- The viscometer is powered by a MEAN WELL GS25A12-P6J power supply. Do not open, expose, modify or touch the internal circuitry of the power supply.

8. Equipment presentation

- Once the equipment package is received, check and confirm the delivery note. If some discrepancy or problem is found, notify immediately the supplier.

- Verify that the viscometer model corresponds to the one that was ordered.

- Read carefully the instruction manual.

- The manufacturer is not responsible for any damages that may result from modifications or lack of maintenance of any of the machine's mechanisms (directive 89/655/CEE).

Fungilab recommends using the carry-case provided with the equipment for making any kind of delivery. Please, keep the carry-case in a safe location. In case of transporting the equipment or during long storage periods, always place each part of the equipment as shown in figure 1. It can be seen that the position of each piece inside the equipment's carry-case is presented. In case of an incorrect packaging, the pieces of equipment can suffer some damage. This damage will not be covered by Fungilab's guarantee.
Parts included within the equipment standard delivery:

- Viscometer head with serial number
- Foot or base, 3 height adjustable knobs for the base
- Nut
- Fastening rod
- Standard spindles
- Spindle guard
- Spindle support
- Calibration Certificate
- Conformity declaration
- Oil certificate document copy
- USB-Memory containing the User Manual (PDF file). The USB-Memory might contain also the company catalogues.
- Power cable
- PT100 Temperature probe
- Clip for holding the PT100 probe
- MEAN WELL GST25A12-P1J power supply

Do not open the power supply due to electrical shock risk. There are not serviceable parts inside. In case of suspecting of a power supply malfunction, please contact FUNGILAB for assistance.

It is mandatory to leave enough free space around the equipment ON/OFF switch, needs to be reachable at any time, especially in case of an emergency or malfunction.

It is very important to treat the silkscreen printed logos carefully when cleaning the equipment. Please use a soft cloth, with isopropyl alcohol (70%).

Standard spindles
Model L: L1, L2, L3, L4
Models R and H: R2, R3, R4, R5, R6, R7

Fig. 1.a First level of the viscometer in its carry-case

Fig. 1.b Second level of the viscometer in its carry-case

9. Equipment Description

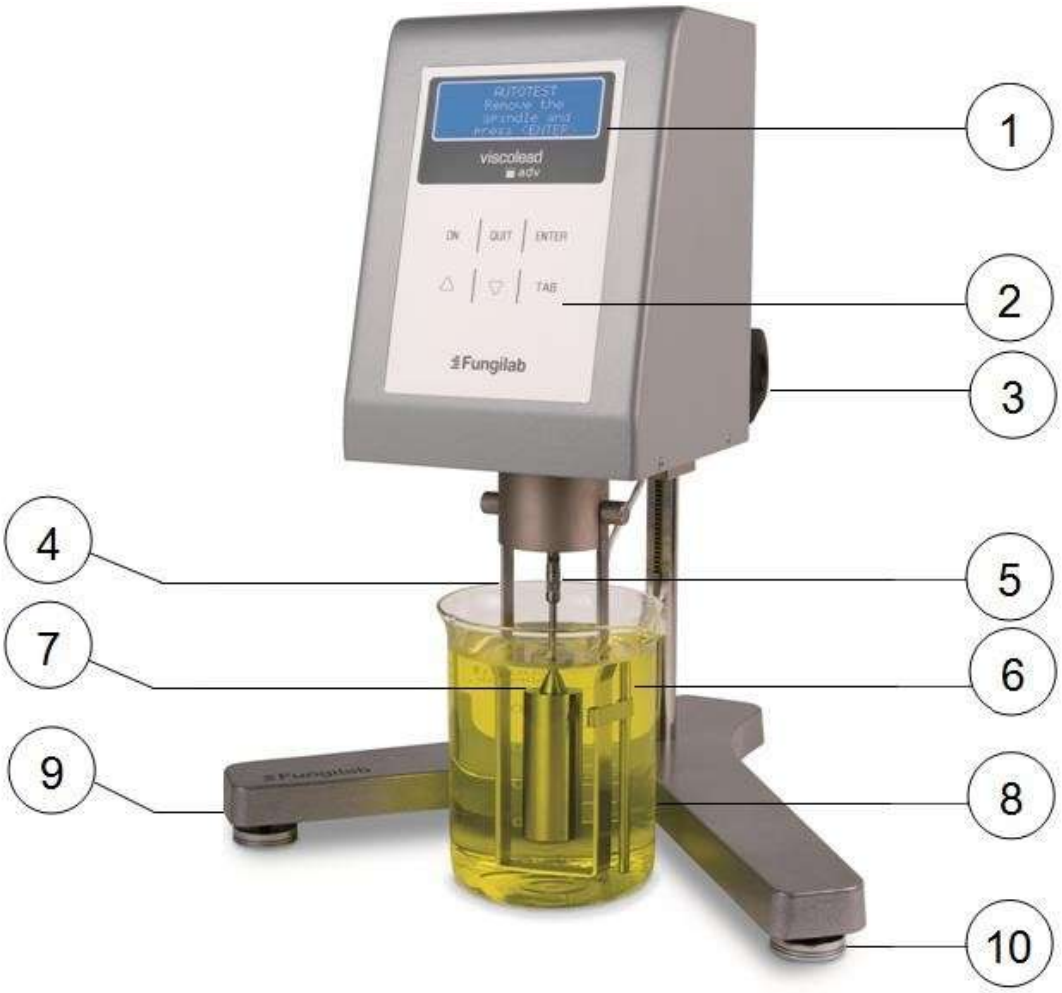


Fig. 2 Frontal view of the equipment

1. Screen
2. Capacitive keyboard
3. Nut
4. Spindle guard
5. Fastening rod
6. Temperature probe
7. Spindle
8. Sample container (not included)
9. Base (viscometer support)
10. Height adjustable knob

Fig.3 Back view of the equipment

1. Serial number label
2. Warning label
3. Level
4. Power switch
5. Power cable slot
6. USB Temperature probe connector
7. USB connector
8. Thermosphere connection

Fig.4. Equipment identification label

Description of the equipment identification label:

1. Viscometer model
2. Viscometer code
3. Serial number of the equipment
4. Voltage and power of the equipment
5. Electronic equipment (specifies throw in trash)

9.1 Equipment set-up

- Remove all of the parts from the carry-case or the standard package. Note the Figure below (fig 5).
- Place correctly the three height adjustable knobs (B) on the Y-shaped base (A).
- Mount the fastening rod (C) with the holding screw (D) at the base (A).
- Attach the nut (F) to the fastening rod. The viscometer should be connected to the nut (F) by means of its rod (E).

Note:

The following process should be done carefully in order to not harm to the shaft of the viscometer. Immediately remove the shaft's plastic protector before beginning to use the viscometer.

- Insert the horizontal rod of the viscometer (E) into the nut (F).

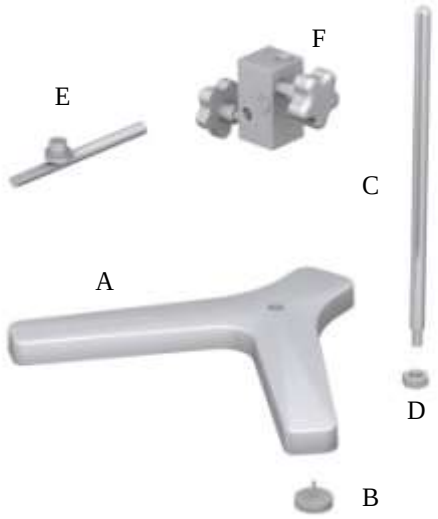


Fig. 5 Set-up for the viscometer base

- The viscometer should be placed on a stable laboratory table or on a stable surface free of vibrations (i.e. caused by other machines or equipment). Do not put the viscometer in direct contact with sunlight or in the middle of any air flow (the temperature of the sample can be easily influenced by the surrounding conditions). The viscometer has been designed to work indoor!
- Turn the height adjustment knobs until the height of the viscometer (located in rod E) is correctly adjusted.
- Plug the power cable into its correct slot located on the back of the equipment (Fig. 3 position 4) and plug it into the power source.

WARNING:

Verify that the voltage and the frequency coincide with the specifications of the power supply (look at the identification). Before turning on the machine, let it sit for some time so that it acclimates to the surrounding temperature in order to avoid a short-circuit caused by condensation. The fluctuations of the power source should not surpass ±10% of the nominal voltage.

9.2 The keyboard and screen

Before starting up the machine, it is recommended to become familiar with the viscometer controls seen in the previous section. The instrument has a 6 capacitive keyboard (Fig. 6) and a 4-lined Alphanumeric Display screen (Fig. 2, number 1) on the frontal part ready to use and they allow the user to interact with the machinery. The screen always shows the operations that the user is carrying out by showing menus that will be explained later on. The measurements collected by the instrument will also be explained in this manual. The keyboard gives the user the mobility throughout all of the menus, the selection of different options and the creation and/or modification of viscosity measurement configurations to suit the user's needs.

The keyboard has the following configuration:

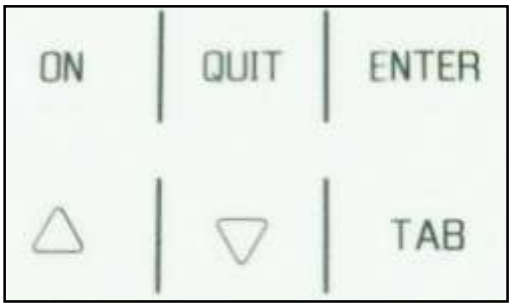


Fig. 6 The keyboard for the ONE viscometer

The different numbered keys will always allow you to type in the proper numerical value (if a modifiable field has been selected).

Key	Function
'Δ'	Go to the previous option; increase a value when a field has been selected.
'∇'	Go to the next option; decrease a value when a field has been selected.
'TAB'	The field selected changes in some menus.
'QUIT'	Return to previous screen and stop the motor during measurements.
'ENTER'	Accept an option or value in a field. It also allows editing to fields that can be modified.
'ON'	Stop/Start the motor during measurements.

In the following sections, the function of each key in the corresponding menus will be explained in full detail, including the exceptions to the general operation.

10. Menu system

Fungilab viscometers work with a system of menus that allow the user to go through the instrument in a quick and simple way. The basic actions in the menus are: moving through the options ('Δ' and '∇' keys), selecting an option ('ENTER' key) or returning to the previous menu ('QUIT" key).

10.1 Start-up

Turn on the switch placed at the back of the machine (number 3, Fig. 3). If after doing this, the machine does not turn on:

- Verify that the power cable is connected to both the power and the Power Supply and that the Power Supply is also connected to the equipment (back part, number 4, Fig. 3).

The machine will beep, indicating that it has started and it will show the following screen:

FUNGILAB S.A. V.5.2 ADVANCE SERIES English

The screen informs the user of the version and the instrument model in addition to the selected language. After a few seconds, the Start-up screen will disappear and the Autotest screen for the viscometer is shown (section 10.2 of this manual).

The equipment initially comes configured with:

- English
- Temperature units in Celsius (ºC)
- Viscosity units in centipoises (cP).

If these are not the desired basic configurations, the equipment can be configured and changed to meet the user's needs. The method of configuring the apparatus by varying these and other parameters is explained in detail in a later section of this manual called 'Instrument setup menu' (section 10.4). Any changes made to the machine will stay configured to the last modification made at the configuration menu and will not return to the factory settings after a restart.
Once the configuration information is given will submit the system to a Autotest.

10.2 Autotest

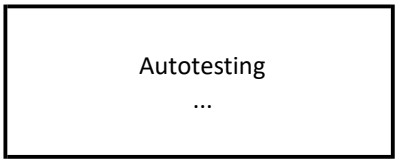
The Autotest menu allows the user to verify the operation of the viscometer in a way that allows detection of motor malfunctions in a simple and practical way.

The following message will appear on the screen:

AUTOTEST Remove the Spindle and Press <ENTER>

VERY IMPORTANT: The Autotest should be carried out without a spindle.

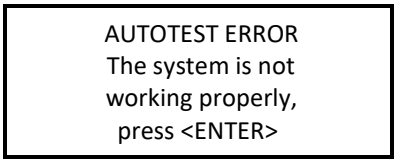
Once this message is shown on the screen, we should confirm that the spindle is not connected. Afterwards, press 'ENTER' and the auto-check process will begin. While this test is running, the screen will show this message:



The dots that appear below the Word ¨Autotesting¨ will appear continuously every half second.

Once the Autotest process finishes, two possible messages will appear, depending on the result of the diagnostic.

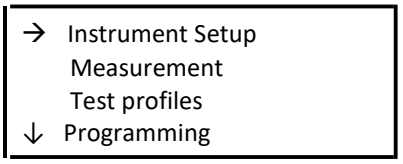
If the viscometer detects an anomaly, it will show the following message on the screen while it emits an acoustic warning:



If this message appears, the technical service from the supplier or manufacturer should be contacted. To get the manufacturer's contact information, press the <ENTER> key and the following format will appear.

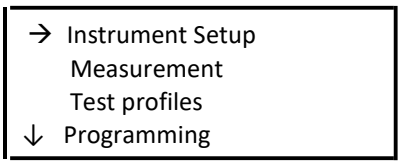
If there is a system error, the equipment will stay blocked, meaning the motor is not working properly. If the machine is turned off and restarted, the same screen will reappear.

In the case of a successful check, the main menu will be displayed.



10.3 Main Menu

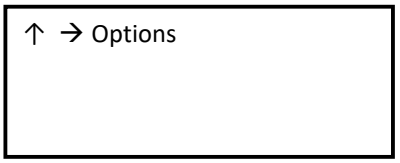
The main menu is the one that appears after the Autotest screen. It is accessed by turning on the machine normally and after a satisfactory result from the test run. The main menu screen will show:



By default, the cursor '→' is placed on the 'Instrument Setup' option.
The menu can be navigated with the 'Δ' and '∇' keys. The current selection will be highlighted and by pressing 'ENTER' you will access to the selected submenu (for more information about each function in particular see the corresponding sections).

The first time the machine is used, it is advisable to access the 'Instrument Setup' option as the first step in order to establish the values for certain parameters of the viscometer such as language and measurement units.

The '↓' symbol indicates that the menu is more extensive than shown. When you are in the first option in menu and press 'Δ' or in the last option of the same menu and press '∇' the screen will change and show:

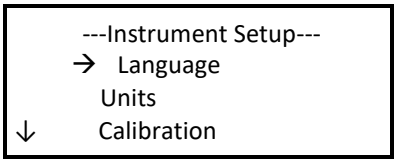


The '↑' symbol indicates that using the 'Δ' and '∇' keys you can return to the first screen of the main menu.

In the following sections, each of the 5 submenus of the main menu can be seen beginning with the configuration submenu.

10.4 Instrument Setup menu

The configuration menu contains those functions that are not standardized and that modify the state and/or operations of the instrument. Once the 'Instrument Setup' option is selected by pressing the 'ENTER' key, the following screen will appear:



Move through the options using the 'Δ' and '∇' keys and select a submenu with the 'ENTER' key.
Once again, the '↓' symbol indicates that the menu is larger than the part shown. Using the 'Δ' or '∇' keys you can change to the following screen:

Using the 'Δ' and '∇' keys you can return to the original submenu.

The main submenu provides the possibility of:

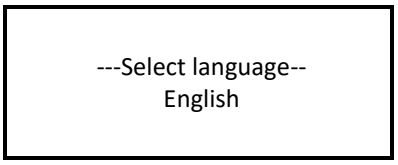
- Changing the working language
- Selecting the measurement units (viscosity and temperature)
- Carrying out calibrations (the machine comes calibrated from factory, therefore it is not necessary to do any calibrations when the machine is received)
- Adjusting the date and time.

The language, time and units should be selected by the user before beginning to work with the equipment so that it functions properly.

10.4.1 Language

Once the configuration menu has been accessed, the first option that the cursor '→' points to is 'Language'. To change the language, this option must be selected by hitting the 'ENTER' key.

When we enter in this submenu, the viscometer will show a screen like the next one:



By using 'Δ' and '∇' the different working languages for this equipment can be seen, which are:

English
French
German
Italian
Japanese
Portuguese
Spanish
Dutch
Polish
Catalan

Once the language has been selected, press 'ENTER' and it will automatically change the language of the menus and return to the configuration main menu screen.

10.4.2 Units.

The ADVANCE-type viscometer allows the user to select the units that are used for measuring viscosity and temperature.

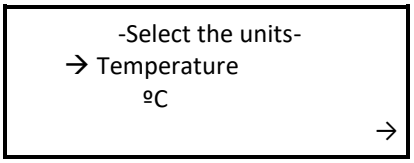
The possible choices for dynamic viscosity are:

- International system of units (Pa·s or mPa·s)
- Centimetre-gram-second system of units (Poise or centipoises)

And those of temperature units are:

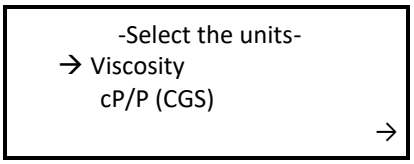
- Celsius (ºC)
- Fahrenheit (ºF)

When the cursor key, '→', points to the units submenu, it can be accessed by pressing the 'ENTER' key and the viscometer will show the following screen:



By default, this submenu screen for 'Units' comes configured with the temperature unit's field selected.

Press the 'TAB' key to change to the viscosity units. Press 'TAB' again to return to the temperature units.



Once the desired field has been selected, the units to be used with the viscometer can be varied by using the 'Δ' and '∇' keys to switch the options.

After the desired units have been selected, press the 'ENTER' key to save the changes and return to the configuration main menu screen.

10.4.3 Calibration

This submenu contains the viscosity calibration options that the user can exploit to recalibrate the viscometer.

IMPORTANT:

The viscometer contains a default calibration element, which is installed during the manufacturing process. It is for this reason that it is unnecessary to calibrate the equipment when using it for the first time. Nevertheless, certain norms of quality recommend that the equipment be recalibrated once a year, which is why we offer the user the possibility of realizing this calibration without needing to send the viscometer back to the usual provider, or to FUNGILAB.

FUNGILAB cannot be held responsible for the measurements taken by an independently recalibrated viscometer and it is essential to follow the instructions given by Fungilab carefully when recalibrating.

Calibration Norms:

- To execute a viscosity calibration, it is necessary to have on hand at least a little standard calibration oil and a thermo-statization system to maintain the sample at a constant temperature. If you do not possess this equipment, then you will not be able to guarantee good post-calibration measurements. FUNGILAB provides upon request the standard oils necessary for the calibration, as well as the accessories need to thermo-statize the oils.

- The calibration of any spindle will only modify the values of that individual spindle. The rest of the equipment's spindles will not be affected by this calibration. If you want to calibrate more than one spindle it will have to be calibrated one by one. The oils used for each spindle will also be different, so for calibration you should have standard silicon oil for each spindle you're calibrating.

- Tables 6, 7 and 8 (page 54) specify the standard oils necessary for each spindle.

This submenu is accessed through the main configuration menu, by choosing the Calibration menu and pressing 'ENTER'. Once at the submenu, the following screen will appear:

```
----Calibration----

→ Reset
↓ Viscosity
```

Using the 'Δ' and '∇' keys, you can select the different options of this submenu, placing the '→' cursor over each option and pressing 'ENTER' to choose it.

Using the same 'Δ' and '∇' keys you can also switch between the original calibration menu screen and the next one:

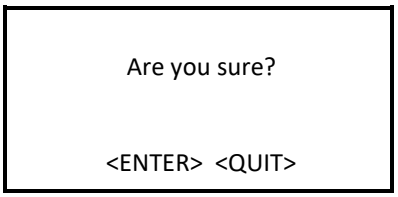
```
↑ ----Calibration----
  → Temperature
```

10.4.3.1 Reset

This submenu contains the equipment's RESET option.
After resetting, the equipment will restore the original viscosity calibration.
Upon entering this submenu, the following screen will appear:

```
WARNING:
RESET THE EQUIPMENT
<ENTER>  <QUIT>
```

Press 'ENTER' to continue with this procedure.
Once the 'ENTER' key is pressed, a second confirmation will be asked as a security measure. The following screen will appear:

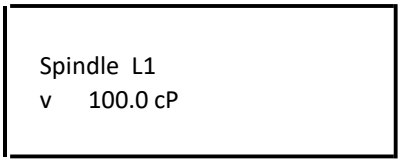


If you press 'ENTER' here, the factory-stage calibration will be restored (calibration, language), the memory will be erased as well as the programming and you will return to the main configuration screen.

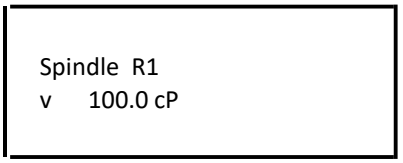
10.4.3.2 Viscosity calibration

When selecting the viscosity option (moving through the menu with the 'Δ' and '∇' key) and pressing 'ENTER' the user will access to the following screens, depending on the model of the viscometer:

Model L



Models R and H



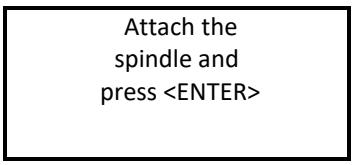
The possible spindles' list to use depends on the model of your viscometer (L, R or H). Thus, in tables 1 to 5 (page 50 and 51) you can see the different available spindles for each model.

Once this field is selected and situated in the list of corresponding spindles, you can select the spindle that you wish to calibrate using the 'Δ' and '∇' keys.

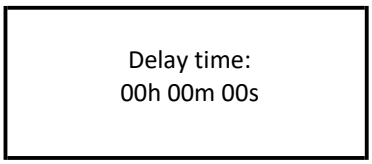
Once the spindle is selected, go to the "Viscosity" field using the 'TAB' key. Pressing 'ENTER', accept the field and introduce the value of the standard oil corresponding to the viscosity calibration. To introduce the data, use the 'Δ' and '∇' keys to increase or decrease the value of each digit. Then, press 'TAB' again to go from one-digit place to another.

Once the value of the oil is determined, press 'ENTER' to continue with the calibration process.

Afterwards, press the 'ON' key and the following screen will be shown:



Once the spindle is in position in the device, press 'ENTER' again and the following screen will appear:



In this screen it is necessary to introduce the time required from the moment you give the command to start the calibration to the moment the device begins the calibration process. This time lapse is frequently used to allow the sample and the spindle to achieve the desired thermal stability before starting the calibration.

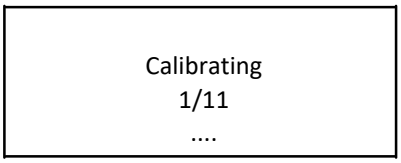
NOTE: *When the digits of this field are not selected, the whole line will be blinking. When the field is selected using the 'ENTER' key, only the place of the digit to be modified will be blinking.*

This field will be permanently opened to modification. To modify the value, use the 'Δ' and '∇' keys to increase or decrease the value of each digit. Then, press the 'TAB' key again to go from a digit's place to another. By pressing 'ENTER' again, you can finalize the field modification and start the calibrating process by pressing 'ON'.

By means of pressing the 'ON' key, a countdown back to zero will begin.

The spindle must already be submerged in the liquid once you confirm the start time.

When the countdown gets to zero, the viscometer will start the calibrating sequence. While the equipment is calibrating, the following screen will appear(example):



On this screen, each step of the calibration process is displayed.

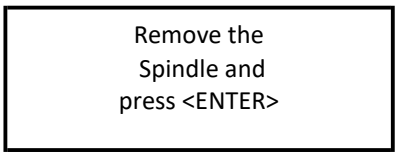
When the process is over, information on the values of the angles and linearity of the calibration are displayed. If the curvature is lower to 2%, press 'ENTER' to confirm the calibration and you will be taken back to the main calibration screen.

The exit key 'QUIT' allows the user to exit to the main menu but never while calibrating (never when the screen looks like the example shown just above).

NOTE: *Exiting mid-calibration denies the equipment a proper calibration and therefore it cannot guarantee accurate results.*

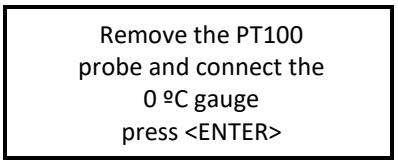
10.4.3.3 Temperature calibration

Once selected the temperature option (by moving through the menu using the 'Δ' and '∇' keys) and pressed 'ENTER', the user will watch a screen similar to this one:



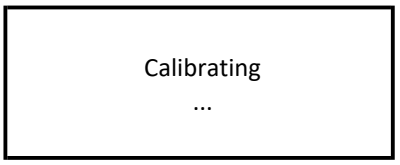
VERY IMPORTANT: The Test-run should be carried out without a spindle.

Once this message is shown on the screen, we should confirm that the spindle is not connected. Afterwards, press 'ENTER' and a screen similar to this one will be shown:

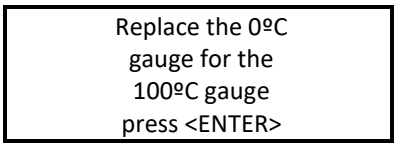


Connect the temperature simulator, using a USB connector, to the back of the viscometer simulating the indicated temperature (in this case 0ºC).

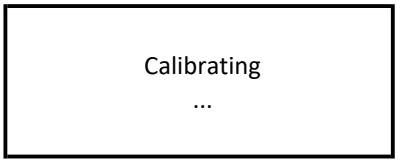
The viscometer's screen will show the instructions to be follow to achieve the calibration of the probe that measures temperature. You'll have to connect the PT100 simulator generating an impedance equivalent to PT100 at 0 degrees Celsius. Once the gauge is connected press 'ENTER' and the following screen will appear:



After a few seconds and once the temperature is calibrated to 0 degree Celsius, a second screen of instructions will appear, containing the following information:



Now, you'll have to connect the PT100 simulator generating impedance equivalent to a 100ºC PT100. With the gauge connected and pressing the 'ENTER' key, this screen will appear:



After a few seconds, a second screen of instructions will appear, containing the following information:

Replace the 100 degree Gauge for the 200 gauge press <ENTER>

Now, the PT100 simulator needs to be connected. That device generates an impedance equivalence similar to the impedance of a PT100 at 200ºC. With the gauge connected and pressing the 'ENTER' key, this screen will appear:

Calibrating ...

After the calibrating is finished, the equipment will show the calibration menu.

***NOTE**: Exiting in the middle of the calibration denies the equipment a proper calibration, and thus, accurate results cannot be guaranteed.*

10.4.4 Time Settings

When the cursor "→" is placed over "Adjust date/time", press the 'ENTER' key to select this option and the viscometer will display the following page:

-- Time settings -- → Date Time

At this point, the user can choose between the date and the time using the 'Δ' and '∇' keys to move through the options and 'ENTER' to choose the desired field.

If you choose the 'time' option, the following screen will appear:

Time	
	hh:mm:ss
Present:	00:00:00
New:	00:00:00

In the second line it can be seen the equipment's current time, which is presented as information only and cannot be modified. In the third line(New), the user can modify the time. To change the time, press 'ENTER' once and the whole field will be selected. Then, using the 'Δ', '∇' and 'TAB' keys, the desired values can be introduced. Once the right value is entered, press 'ENTER'.

The date change functions in much the same way as the time change. Once this option is selected, the following screen will appear:

Date	
	dd/mm/yyyy
Present:	00:00:0000
New:	00:00:0000

In the second line you can see the equipment's current date, which is presented as information only and cannot be modified. In the fourth line you can modify the date (new date). To change the date can be done by pressing 'ENTER' once and the whole field will be selected. Now, using the 'Δ', '∇' and 'TAB' keys the desired values shall be introduced. Once the right value is entered, press 'ENTER'.

If the user presses the 'QUIT' key the modification will be cancelled and the previous field value will be restored.

10.5 Measurement Configuration

The measurement configuration menu allows access to the basic functions of the device: measuring fluid viscosity. From the main menu screen, with the '→' cursor over the 'Measurements' field, press the 'ENTER' key to choose this option.

After choosing this option, you will see one of these screens, depending on the viscometer model you have:

Model L

```
    --Measurement Config.--
SP: L1              RPM:100.0
d:              1.0000  g/cm3
Max:                    60.0
```

Model R and H

```
     ----Measure Config.----
SP: R1             RPM:100.0
d:             1.0000  g/cm3
Max:                   100.0
```

To move through the fields cyclically use the 'TAB' key and with the 'ENTER' 'Δ' and '∇' keys you can proceed to edit each one of the fields. Let's first look at what each field represents and how to modify it.

- SP: the field that indicates which spindle we use for the measurement.
- RPM: the field indicating the working speed.
- d: indicates the density of the sample
- Max: Maximum viscosity to be determined with the speed and the spindle selected.

The SP field together with the selected speed will determine the maximum and minimum viscosity values (tables 9 to 23, from page 56 and on), as well as the existence of a shear stress measurement (if you're using coaxial spindles). To modify the spindle, first, it is needed to select the field using the 'ENTER' key. The viscometer will only show the spindles that are compatible with your model. Once the spindle field is selected, we use the same direct selection method previously explained in the section about viscosity calibration.

IMPORTANT: *Selecting a spindle that doesn't correspond to the ones adapted to your model will cause measurement problems.*

The RPM field (revolutions per minute) indicates the speed at which the test will be performed.
The ADVANCE series incorporates 18 pre-determined speeds: 0.3, 0.5, 0.6, 1, 1.5, 2, 2.5, 3, 4, 5, 6, 10, 12, 20, 30, 50, 60, 100 rpm.
The viscosity of the liquid and the spindle used determine the speed (tables 9 to 23, from page 53 and on).

Speed modification: once the corresponding field is selected using the 'TAB' key, you can move through the pre-established speed using the 'Δ' and '∇' keys. If you want to keep the selected speed, press the 'TAB' key to change parameters.

You have also a quicker option for changing the speed. When the speed field is selected (it will be blinking), press the 'ENTER' key to access this option. All of the digits will be blinking and they can be modified according to the user's needs. Using the 'Δ' and '∇' keys, each digit can be modified, cyclically, between 0 and 9. The ',' will be used as a decimal market. If two commas are accidentally entered, the value will be considered invalid and thus, it will not be saved. At this time, the process shall need to be repeated. To change the digits, use the 'TAB' key and to confirm the entered value (as long as it is a coherent and valid one), press 'ENTER' again.

NOTE: *If, during modifications, you introduce a speed that doesn't exist amongst the pre-programmed speeds, the machine will automatically replace your introduced speed by the closest one to it among the pre-determined speeds.*

NOTE: *If you modify the density, the viscometer will give its measurements in cSt (centiStokes), whereas if you conserve the initial density (considered the density by default), the measurements will be in cP (centipoises), P (Poise) or mPa·s, Pa·s.*

If, once the values of all of the fields are confirmed, press the 'ON' key and you will go on to the measurement screen. If instead you press the 'QUIT' key, you'll return to the main menu screen, losing all of the data introduced in measurement configuration.

10.5.1 Measurement Screen

You can access this screen by pressing the 0N key after the introduction of the measurement parameters. The spindle will start rotating, which means that the equipment is ready to start collecting data. In the next picture, an example of the data shown on the screen at this stage can be seen:

------Measuring------	
SP: L1	RPM:100.0
v:	30.4 cP
50.1 %	T: 25.1ºC

As the equipment goes about collecting viscosity data (one piece of data for each rotation of the spindle), the information on the screen will be updated. On the screen you will see:

- SP: Current spindle. Selected on the previous screen.
- RPM: Revolutions per minute. Value selected on previous screen.
- V: Viscosity. Value expressed in cP or mPa·s, or cSt (in the case that a density different from the default one is introduced).
- %: Certain percentage of the base scale. Percentage value of the curvature of the spring in relation to the base of the same scale.
- T: Temperature of the sample (ºC or ºF)

NOTE: *The speed field will be blinking until the motor speed is stable.*

NOTE: *Depending on the selected speed, it is possible that the speed reading will take a few seconds or minutes to appear. It's important that the viscometer has made at least five rotations (which equals five measurements) before considering the measurements to be valid, as the device needs that time to stabilize. It's also important to only take into account the temperature of a stable sample.*

In addition to visualize the obtained measurements of the sample-on-test, the user can perform other actions in parallel from this screen.

Using the 'Δ' and '∇' keys, you can increase or reduce the speed of the spindle's rotation (RPM). When pressing one of these two keys, the rotation speed increases or decreases, respectively, from the previous speed.
This way, we can comfortably modify the turning speed without having to leave the measurement screen.
When making a speed change, the field will start blinking again until the motor speed stabilizes.

To make a unit change, whether it's in viscosity or in temperature, the equipment will have to take into account the stabilized rotation (speed field (RPM) not blinking). With the 'TAB' key, the viscosity field will blink for five seconds. If you then use the 'Δ' and '∇' keys, you can vary the units.
To save the changes, press 'ENTER'. If you do not do this within five seconds, the changes will go unsaved.
The units in the temperature field can be modified using the same process but you will need to use the 'TAB' key again when you've selected the viscosity field (it will be blinking).

IMPORTANT: *When the certain percentage of the base scale is lower than 15% or is as high as 100%, the measurement cannot be considered valid and the equipment will emit a warning beep with every rotation made under these circumstances.*

If you are using coaxial spindles (TL or TR) or the low-viscosity spindle (LCP/SP) you can access the other measurement information screen.
By pressing 'ENTER' in the main measurement screen, the following screen will appear:

------Measuring------	
SP: TR5	RPM:100.0
SR: 28.0	SS: 200.9
50.1 %	T: 25.1ºC

This screen shows the same values of Spindle, Revolutions per Minute, Percentage and Temperature of the sample that were shown on the previous screen. But in addition this screen shows:

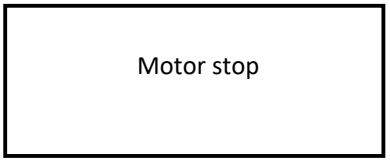
- SR: Share Rate.
- SS: Share Stress.

Using the 'ENTER' key again you can return to the original Measuring screen. You can also, if a Time to Stop is defined (see section 10.7 for more information) press the 'TAB' key to show the countdown as the following screen represents:

------Measuring------	
Time:	00h 00h 59s

In the other hand, if you are not using coaxial spindles (TL or TR) or the low-viscosity spindle (LCP/SP) but there is a Time to Stop programmed, the 'ENTER' key will lead you to the countdown screen.

With the 'ON' key you can stop or start the motor, which allows for momentary pauses in an experiment. When you press this key, the equipment will show the following message:



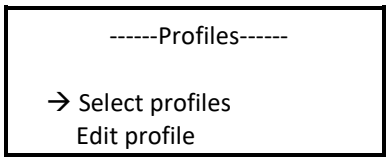
If you press the 'QUIT' key when you see the message above, the viscometer will abandon the measuring and return to the main screen.

If you press the 'ON' key, the equipment will restart the measurements with the same configuration.

10.6 Test Profiles

FUNGILAB viscometers incorporate a group of programmable logs that allow configurations to be saved in order to speed up use of the machine when carrying out measurements of a certain frequency.

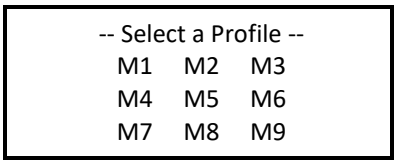
From the main menu screen, select the Logs option by using the 'Δ' and '∇' arrows and press the 'ENTER' key to accept. The viscometer will show the following screen:



The first option will start a measurement with some configurations already recorded in the instrument's log and the second is for saving the measurement options of a new configuration. Select one field or the other by using the 'ENTER' key.

10.6.1 Edit Test Profile

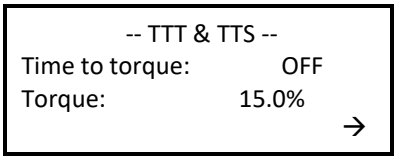
To select this option, the 'ENTER' key should be pressed when the cursor "→" is placed on the "Edit profile" option line. The viscometer will show the following screen:



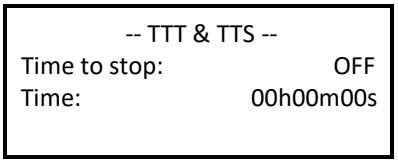
To choose one of the logs, use the 'TAB' key. In the log recording there are three option blocks that you must configure once the desired log has been chosen. We will now explain viscometer programming, output conditions and specific configurations for the measurement.

10.6.1.1 Viscometer programming

Once the log is chosen, the following screen will appear:



By pressing "→" the next image can be seen:



As stated before, these abbreviations mean:

TTT: Time to Torque. User must set a torque value (%), at which the viscometer will stop the measurement. The screen will show the obtained viscosity value at this moment in the torque. (see section 10.7)

TTS: Time to Stop. You must set a time for the experiment and a time for the viscometer to stop. Once the device has arrived at the determined time, the equipment will stop and display the value of the viscosity (see section 10.7)

The two fields that can be activated in this screen are the TTT and TTS.
To select a field, use the 'TAB' key to go through the options in a cyclical way. The selected field will show intermittently the necessary information.

TTT and TTS can only be ON or OFF. To change from one to the other the user must select the desired field and use the 'Δ' or '∇' keys to change the status.

If no mode is chosen, the user cannot access to the 'Torque' or 'Time' fields. These fields need to be activated ('ON' in the fields TTT and TTS, respectively) in order to access them.

Once the 'Time to Torque' field is activated by pressing 'ENTER', you can access the 'Torque' option by pressing 'TAB' and then 'ENTER' again to edit. Use 'TAB' and the 'Δ' or '∇' keys to reach the desired value and press 'ENTER' again to save the changes (it should be a numerical value between 15 and 95). This value will remain saved even if the option is deactivated ('OFF').

'Time' is modified in a similar way. You should have the 'TTS' option activated (pressing 'Δ' or '∇' keys to change the mode to 'ON'). Once it is selected, use 'TAB' to enter the desired value.

The selected field will be blinking on the screen until it is modified, which you can do by means of 'Δ' or '∇' key and 'TAB'. By pressing 'ENTER' again, these changes remain saved. If the 'TTS' option is deactivated, the value will still be saved in the memory.

NOTE: *It is impossible to select both the TTT and TTS functions at the same time.*

10.6.1.2 Output options

By pressing the 'ON' key from the previous TTT and TTS configuration screen, the viscometer will show you the following screen:

Status	OFF
Ini	00h 00m 00s
End	00h 00m 00s
Inc	00h 00m 00s

- Ini: record start time, 'Beginning'
- End: data record end time.
- Inc: the increments by which samples are taken.

To modify each field, press 'ENTER'. The selected field will blink on the screen until it is modified, using the 'Δ' or '∇' keys or the 'TAB' key. To save the changes press 'ENTER', which will unselect the field and save the entered values.

In the 'options and output configuration' screen (as we will now see), the user can begin the configuration of the measurement or experiment.

10.6.1.3 Measuring configuration options

The 'ON' key will make appear a screen resembling to this one:

----Measure Config----	
SP: L1	RPM:100.0
d:	1.0000 g/cm3
Max:	60.0

The modification on this screen has already been explained in detail in section 8.3 Measurement configuration menu.

Once the measurement parameters are configured, press the '0N' key to save them into the memory. The equipment will move on to the next screen and the recording process will be finalized.

------Profiles------
→ Select profile
Edit profile

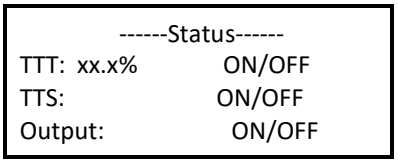
To assure the memory has been accurately recorded the process can be checked in 'Use Log'.

10.6.2 Select Profile

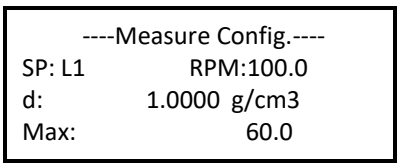
If the user wants to use some of the machine's logs, the 'ENTER' key should be pressed once the cursor "→" is placed on this option and the following screen will appear:

-- Select a Profile --		
M1	M2	M3
M4	M5	M6
M7	M8	M9

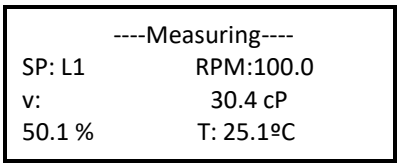
Once the log is chosen and the 'ENTER' key is pushed (use 'TAB' key to move through them), the following screen will appear. In the sample figure all of the possibilities are shown. Only one of the two words, ON/OFF, will appear depending on which function is active:



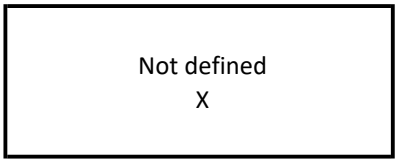
This screen is the same one as the auxiliary screens of the measurements for this machine. The information shown will not be able to be modified under any condition, it is only shown to inform the user. Once the user has this information on the screen, by pressing the 'ON' key the measurement can begin and then the measurement screen will be shown. If the 'ENTER' key is pressed the measurement configuration page is accessed and if the key is pressed again, the status page appears.



Once on the measurement configuration screen, the measurement details can be seen but not modified. Now if the 'ON' key is pressed, the measurement can begin.



If a log that has not been recorded previously is selected by mistake (the viscometer comes from the factory with empty logs) and if the 'ENTER' key is pressed, a screen like the following will appear:



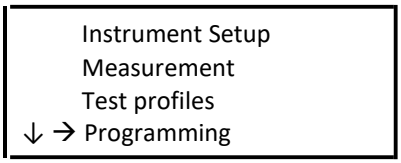
"X" being a log number from 1 to 9. If the following screen is visualized:

Means that the slot M3 would have been selected and it would be there without having been recorded on (empty). By pressing the 'ENTER' key again, the log selection screen will reappear to be able to select another log.

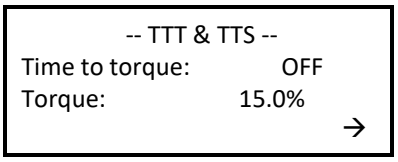
10.7 Programming

The Programming menu contains the functions that allow some optional applications to be programmed for the measurements. The TTT (Time to Torque), TTS (Time to Stop) and the Speed Configuration are applications that are complementary to the normal measurements.

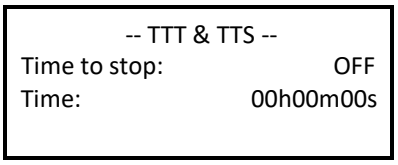
From the main menu screen you must place the cursor "→" on "Programming", as seen in the following diagram:



By pressing "ENTER", you will see the following screen:



By pressing "→" the next image can be seen:



This screen will allow to activate and configure the 'Time to Torque' (TTT) and 'Time to Stop' (TTS) options that we will currently explain:

- Time To Torque (TTT): the TTT experiment measures viscosity until torque arrives to the prefixed value. To start the experiment is needed to obtain five consecutive measures with a difference in the torque minor than 2%, after that, the device it will measure viscosity until cross the prefixed value of torque (rising or falling). When the viscometer stops, the last viscosity measurement is displayed on the screen.

- Time to Stop (TTS): the 'Time to Stop' field is where you program the amount of time you want the measurement or experiment to last. Programming this field with a time limit will define the maximum duration of the viscometer's measurement. When the viscometer stops because the program is finished, the last viscosity measurement will be displayed on the screen.

To select the field that you want to activate (TTT or TTS) you use the 'TAB' key and you can jump from field to field cyclically. The selection of fields will start in 'Time to Torque'. The field that is selected will be intermittently displayed for further information.

The options for the two fields TTT and TTS can only either be 'ON' or 'OFF'. To vary this option you need to have the right field selected and use either the 'Δ' or '∇' keys to jump from option to option.

If the 'Time to Torque' or 'Time to Stop' fields are not activated (on the 'ON' position), then the 'Time' and 'Torque' fields cannot be accessed.

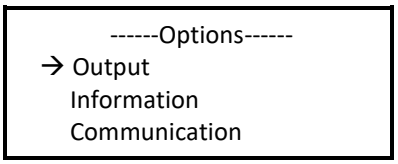
Once the 'Time to Torque' field is activated ('ON' position), you can access the 'Torque' field by typing the 'TAB' key. The field should begin to blink. You hit 'ENTER' to proceed to the modifications. By using the 'TAB' key you can introduce the desired torque value (between 15.0 and 95.0) and by hitting the 'ENTER' key

again, you can keep this amount. This number will remain saved, unchanged, even if the 'Time to Torque' option is deactivated (by changing the field option to 'OFF').

The 'Time' field works in a similar way. The user needs, first, to activate the 'Time to Stop' option (on 'ON' position) and select it using the 'TAB' key. Once the field is selected, the user shall press the 'ENTER' key and enter the desired numerical amount into the 'Time' fields using the 'Δ' or '∇' keys. Pressing the 'ENTER' key again, the changes are saved and these will remain unchanged until a new value is entered in the same way. If the user deactivates the 'Time to Stop' option (in 'OFF' position), the value will be saved.

10.8 Options

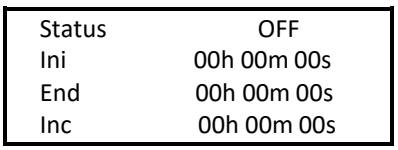
The Options menu contains the information and output options that can be set in the Fungilab Viscometers. When the '→' cursor is on the 'Options' field of the main menu, you must select it by pressing 'ENTER'. The viscometer will show the following screen:



Using the 'Δ' and '∇' keys, you can move our cursor through the options in a cyclical way and to choose one of them, the '→' cursor must be on the field when you press 'ENTER'.

10.8.1 Output

The storage submenu allows to enable the recording system of the viscometer. This selection is mandatory in order to output such information: storing a file in a USB memory Stick. The Output menu presents the following screen:



The selected field will remain blinking on the screen until it is chosen for modifications. To modify each field you must press 'ENTER' once the field is selected and then introduce the values using 'Δ' or '∇' keys or the 'TAB' key to enter a number in each digit place. To save the changes, press 'ENTER', whereupon the field will be unselected and the changes saved.

Screen Information:

- Ini: Begin time of recording.
- Fin: End time of data recording.
- Inc: By which increments of time a sample is taken.

10.8.2 nformation

If you select the 'Information' option, you will be brought to a screen in which the manufacturer contact information will be displayed, resembling this:

FUNGILAB S.A.
Phone:+34 93 685 35 00
Fax: +34 93 685 37 50
www.fungilab.com

This option is incorporated as a means of security in the case of loss of the present document or the displacement of any reference to the company in technical support or on paper.

10.8.3 Comunication

This option allows downloading the data saved in the Viscometer's memory to an external USB-memory stick. When this option is selected, the following menu appears:

------Select an option------
→ USB Stick

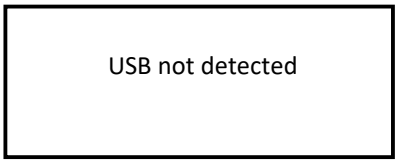
Before start to download the user shall connect the USB-memory stick to the USB port on the viscometer at it is shown at the next image:

Fig. 7 USB-memory stick connection

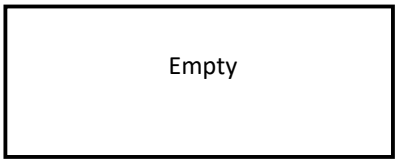
NOTE: the memory stick only works in the selected USB port. Never connect it in any other port of the viscometer.

Press 'ENTER' to start the download.

If there is no USB memory stick the viscometer will not change its screen and it will be waiting for the connection of a USB memory.



If no data is stored, the next screen will appear:



If the viscometer detects the USB stick connected to the suitable USB connector the download will start, showing this text on the screen:

If a USB-memory has been used to download the data, the viscometer will create a folder named 'FUNGILAB' in its root directory. The file or files resulting from the download will be stored in this folder. The first file is named 'FDL0' and the following ones are 'FDL1', 'FDL2' and so on. The files are saved in a CSV (Comma-Separated Values) format, so they can be opened using a plain text editor or a spreadsheet. An example of a file generated by this feature can be seen in the following screenshot:

Fungilab Datalogger						
Viscometer:	EEXR00000					
Date:	10/01/2015					
Measure type:	Normal					
Spindle type:	R1					
Start time:	02:10:11					
Stop time:	02:10:35					
Density:	1.000 g/cm^3					
Visc. Unit:	cP					
Temp. Unit:	ºC					
S.R. Units:	s^-1					
S.S. Units:	g/(cm·s^2)					
Time	Speed	Viscosity	Torque	Shear Rate	Shear Stress	Temperature
2:10:14	40.00	0.00	0.00	0.00	0.00	25.00
2:10:15	40.00	0.00	0.00	0.00	0.00	25.00
2:10:16	40.00	0.00	0.00	0.00	0.00	25.00
2:10:17	40.00	0.00	0.00	0.00	0.00	25.00
2:10:18	40.00	0.00	0.00	0.00	0.00	25.00
2:10:19	40.00	254.44	70.78	0.00	0.00	25.00
2:10:20	40.00	240.78	96.45	0.00	0.00	25.00
2:10:21	40.00	240.78	96.45	0.00	0.00	25.00
2:10:22	40.00	239.95	96.36	0.00	0.00	25.00
2:10:23	40.00	237.39	95.25	0.00	0.00	25.00
2:10:24	40.00	237.39	95.25	0.00	0.00	25.00
2:10:25	40.00	235.44	94.56	0.00	0.00	25.00
2:10:26	40.00	217.68	87.38	0.00	0.00	25.00
2:10:27	40.00	217.68	87.38	0.00	0.00	25.00
2:10:28	40.00	213.23	85.62	0.00	0.00	25.00
2:10:29	40.00	198.20	79.58	0.00	0.00	25.00
2:10:30	40.00	190.94	76.66	0.00	0.00	25.00
2:10:31	40.00	190.94	76.66	0.00	0.00	25.00
2:10:32	40.00	184.40	74.03	0.00	0.00	25.00
2:10:33	40.00	185.12	74.32	0.00	0.00	25.00
2:10:34	40.00	185.12	74.33	0.00	0.00	25.00
2:10:35	40.00	178.07	71.49	0.00	0.00	25.00
22 measurements in total						

11. Important Rheological Information

To obtain precise results it is necessary to know the most important rheological properties of the sample.

Newtonian fluids
The viscosity of these fluids does not depend on the shear rate meaning that at any speed the viscosity is the same. Only temperature affects the viscosity; changes of 1ºC can provoke a change in the viscosity of up to 10%.

Non-Newtonian fluids

The viscosity of this type of products changes with the speed variable. Due to this inconsistency, the term *Apparent Viscosity* is habitually used.

Within the classification you can find two different groups:

Time-independent non-Newtonian fluids
Time-dependent Newtonian fluids

Time-independent non-Newtonian fluids

The viscosity of a time-independent non-Newtonian fluid depends on the temperature and the speed gradient.

Pseudo plastic Fluids:
The viscosity diminishes when the speed gradient increases.
Practical examples: paints, shampoos, fruit juice concentrate, adhesives, polymers, grease, starch, etc.

Dilatants-Fluids:
The viscosity increases with the speed gradient.
Practical examples: clay, sweets components, etc.

Plastic Fluids:
These fluids only start to flow after having been submitted to a certain force (shearing force). They behave like solids in static conditions.
Practical example: Ketchup.

Time-dependent non-Newtonian fluids.

The viscosity of time-dependent non-Newtonian fluids is dependent on the temperature, on the speed gradient and on time.

Tixotropical fluids:

In these substances the viscosity diminishes with time when the fluid is subjected to a constant speed gradient. These substances tend to return to their previous viscosity once the speed gradient ceases to be applied.
Practical examples: Many products in industrial food production (yogurt, etc.)

Reopectic fluids:
In these fluids, the viscosity increases with time when the fluid is subjected to a constant speed gradient.
These substances tend to return to their previous viscosity once the speed gradient ceases to be applied.
These fluids are not very common.

NOTE: *The turbulent behaviour of a fluid can produce falsely high results in viscosity tests. Normally, turbulent behaviour is due to an excessively high rotation speed in relation to the viscosity of the sample (see detailed Warning further on).*

FACTORS AFFECTING VISCOSITY

There are many variables that affect the rheological properties of products, so it is very important to take the following factors into account.

Temperature

Temperature is one of the most obvious factors affecting rheological behaviour.

It is essential to consider the effects of temperature on viscosity in the evaluation of materials that are subject to changes in temperature during its use or other processes. Some examples of this are motor oils, greases and adhesives.

Shear Rate

When a fluid is subjected to variations in the speed gradient during its process or use, it is essential to know its viscosity at the projected speed gradients.

Examples of materials, which are subjected to and affected by important variations in speed gradient during its process or use, are: paints, cosmetics, liquid latex, some food products such as ketchup and blood in the human circulatory system.

Measurement conditions

The measurement conditions of a material during its viscosity reading can have a considerable effect on the results of this measurement. Consequently, it is important to be careful and control the environment and conditions of any sample subjected to analysis.

Variables such as the type of viscometer, the speed/spindle combination, the sample's container, the absence or presence of a spindle protector, the temperature of the sample and the sample preparation techniques, etc, can affect not only the precision of the reading but also the real viscosity of the sample.

Time

Ageing under the same speed gradient conditions affects tixotropical and reopectical fluids.

In some fluids the action of time combined with the proportion of the shear is very complex. In these cases, one can observe, with time, a return to the original fluid state.

Previous conditions

The conditions that the sample is subjected to before the viscosity reading can significantly affect the results, especially with heat-sensitive fluids or ageing.

Thus, the storage condition and the sample preparation techniques should be conceived to minimize effects on the viscosity measurements.

Composition and additives

A material's composition is a determining factor in its viscosity. When the composition is altered, whether this is by changing substance proportions that compose it or adding other substances, important changes can be observed in their viscosity.

For example, adding solvent to printing ink reduces the viscosity of the ink and other types of additives are used to control the rheological properties of paints.

VISCOSITY MEASURING PROCEDURES

Data history
We recommend documenting the following information each time you take a viscosity measurement:

- Model or type of viscometer
- Spindle (and accessory)
- Rotation speed
- Sample container
- Sample temperature
- Sample preparation procedure (if existent)
- Spindle protection use

The process is necessary in the event of comparison of results with other organizations, in the interest of being able to guarantee the possibility of reproduction of the results obtained.

The spindle and its protection
Examine each spindle before using it. If it's damaged or eroded in such a way that its dimensions are changed, it will provide false results for your viscosity reading.
The spindle protector (provided with every Fungilab rotational viscometer) protects the spindle and the viscometer axle and it is important for the reading of low viscosities with standard spindles.
The protector should always be used. In the event that it is not used, its absence must be reported in the measurement procedure notes.
The protector isn't used with most of the accessories.

Speed selection and spindle
If there is no described work procedure, the best method for the selection of the spindle for each speed is "trial and error". The objective is a torque reading between 15 and 95%, according to the type of product in question and a percentage higher than 50% is recommendable.
If you know the fluid's approximate viscosity, the quickest spindle/speed selection method is referring to the tables of maximum approximate viscosity.
When you do tests at different speeds, you should select a spindle with which all of the speeds show a torque reading of between 15 and 95%

GENERALLY:

RPM INCREMENT $\Rightarrow$ READING PRECISION INCREMENT

SPINDLE SIZE-REDUCTION $\Rightarrow$ READING PRECISION INCREMENT

(Except for the non-Newtonian fluids that change their viscosity value when the rotational speed is modified. In these cases we recommended measuring with a determined speed and using a comparison method.)

Size of the sample container
For measurements using the Fungilab viscometer, we recommend working with containers with an interior diameter of 83 mm or more. The usual container is a 600 ml precipitation vase.
If a smaller container is used, the viscosity values could be greater, especially with low-viscosity fluids.

Sample conditions
The sample should be free of air bubbles.
It should be exposed to a constant and uniform temperature. Before doing the viscosity readings, make sure that the spindle and its protection are the same temperature. Usually, thermostatic baths are used to maintain the sample at the desired temperature.

The sample should have the properties of a homogeneous liquid; this means that it cannot have particles capable of being precipitated, deformed by the shear rate or decomposed into smaller particles.
The measured substances shouldn't be subject to chemical or physical changes during the measurement.

Other essential conditions
Experiments in conditions in which turbulent behaviour can be encountered should be avoided.
The condition should be that of stationary fluid. Accelerations or retarding processes are excluded from the parameters of measurement.

Spindle immersion
The standard spindle should be submerged to the halfway mark in the axle. An erroneous immersion can compromise the result of the viscosity measurement.
With the disc spindles you should avoid the creation of air bubbles, which could remain under the disc. To this end you should insert the spindle laterally and smoothly and bring it over to the centre of the sample. Once it is there, attach it to the viscometer's axle.

Precision and Repetition
FUNGILAB viscometers guarantee a precision of ±1% from the bottom of the speed/spindle combination scale and a repetition of ±0.2%.
The precision of temperature measurement is ±0.2 ºC.

Getting a viscosity reading
Before working with the viscometer you should make sure of the following points:
The viscometer is properly fastened to the stick and level.
Both spindle and speed are selected. (read attentively the section about speed and spindle selection).
The spindle is carefully placed and fastened.
The instructions and necessary parameters for obtaining a viscosity reading have been carefully read in the user's manual.
Once the readings have been initiated, allow some time for stabilization, the length of which will be in function of the rotational speed during the measurement.

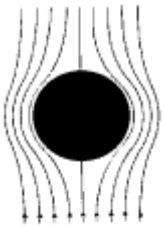
IMPORTANT WARNING
When you wish to obtain viscosity reading with FUNGILAB rotational viscometers, there are two considerations to take into account:

The obtained viscosity results must be between 15% and 100% of the torque range, for whichever spindle/rotational speed combination.
The viscosity reading must be executed under laminar flow condition, not turbulent flow conditions.

The first consideration is linked to the precision of the instruments. All of the FUNGILAB rotational viscometers guarantee a precision of (±) 1% from the bottom of any spindle/rotational speed combination scale.
Working with less than 15% of the bottom of the scale is not recommended due to that the potential (±) 1% error in the viscosity is relatively big compared to the equipment reading.

The second consideration has to do with fluid mechanics. All of the rheological measurements of fluid flow properties must be taken under laminar flow conditions. Laminar flow is when all of the movements of the fluid particles are in sheets, directed by an external applied force.

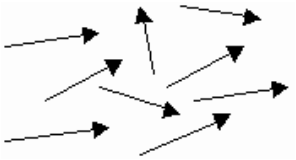
The flow lines represent speed and fluid flow direction.
Laminar flow: "straight" flow lines. Relatively easy to predict. Generally slow.



Turbulent flow: "non-linear" flow lines. Impossible to predict the exact movement of the fluid. Very quick.

For rotational systems, this means that the fluid's movement must be circumferential. When the internal forces of a fluid end up being too great, the fluid can become a turbulent flow, in that the particles that make it up become unpredictable, making it impossible to analyse it with standard mathematical models. This turbulence creates a false reading which is a lot higher than the real one, without linear growth and totally unpredictable.

For the following geometries, these transition points have been found to be approximate to turbulent flow:



1) Spindle L1:	15 cP to 60 rpm
2) Spindle R1:	100 cP to 50 rpm
3) Adaptor LCP:	0.85 cP to 60 rpm

Turbulent flow conditions will always exist in these conditions as long as the RPM/cP ratio exceeds the values listed above.

12. Accessories

12.1. Low viscosity adapters (LCP and LCP/B)

Low viscosity adapters (LCP y LCP/B) do not come with the standard delivery. Any of these two versions (with or without thermo station jacket) must be ordered as an additional accessory. Both LCP and LCP/B accessories are supplied complete with a spindle.

Low viscosity adapters allow more precise measurements than using the standard spindle. The viscometer can measure very low viscosity levels, from 1 cP (when using the L model).
Thanks to its cylindrical geometry shape, it is possible to get Shear Rate determinations and Shear Stress.
Only a small quantity of a sample is needed (16 ml.)

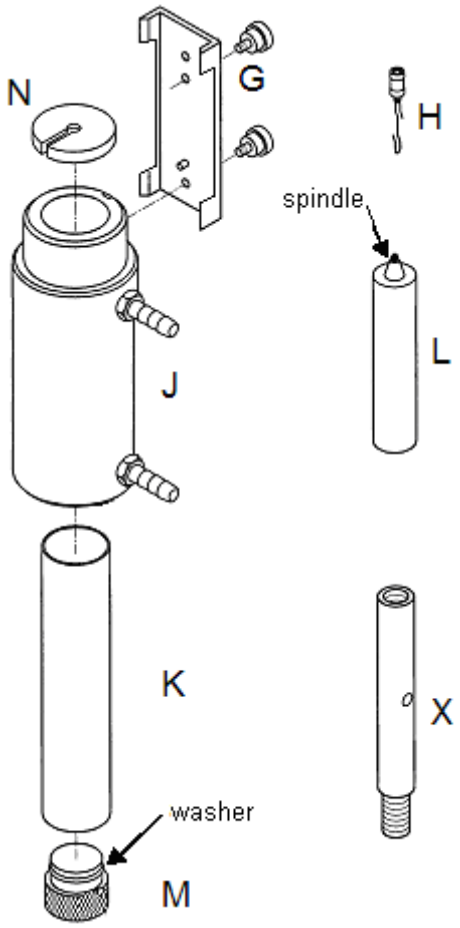


Fig. 8: LCP Spare parts

Fig.9: LCP Adapter assembled in viscometer

12.1.1 Mounting

The mounting process is different according to the types of low viscosity accessories (LCP and LCP/B).
The difference between them only remains that the LCP has a thermo station jacket (J) and a container (K) and the LCP/B only incorporates a container (K). The LCP screw its thermo station jacket (J) to the connector (G), on the other hand, the LCP/B screws the container directly to the connector (G). Now is detailed the LCP assembling

- Unplug the viscometer.
- Attach the extension (X) between the base Y shaped (A) and the rib (C). Use a 19 mm adjustable spanner in order to fasten the nut (D).
- Assemble the viscometer again starting with the base. The extension (X) is necessary because of the length of the LCP adapter. Without this extension the assembly of this accessory would be difficult, especially the assembly of the spindle.

Fig. 9: Mounting the LCP adapter extension.

- Close the sample (K) container with the stopper (M).
- Insert the container (K) to the lower part, in the circulation jacket (J) by turning it gently.
- Fasten the circulation jacket (J) to the connector (G).
- Fill the sample container with a 20 ml syringe, or less and fill the 16 ml sample container.
- Connect the hook (H) and the spindle (L)
- Insert the spindle (L) in the circulation jacket (See the note * below)
- Fasten the connector (G) to the hole in the back of the viscometer's metallic base. **(See the note ** below)**
- Screw it with the viscometer axle by turning it clockwise.
- Check the level of the sample. It should be approximately in the middle of the cone, which is connected to the spindle connector (H). Figure 10 shows more information about this.
- Place the upper stopper (N) over the sample container.

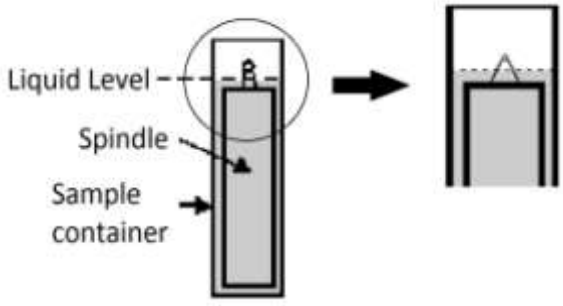


Fig. 10: Full LCP adapter.

***Important:**
Do this slowly since the spindle must be inserted correctly in the sample. When working with a more viscous sample be careful to avoid pulling the spindle upwards. Hold the spindle connector.

****Important:**
The piece named G has two possible holes for the upper screw.
The top hole is an universal hole to screw our low viscosity adapter to other viscometers.
The bottom hole is to screw Fungilab pieces.

NOTE:

Before starting with the measurements, make sure the viscometer is correctly balanced (check the bubble level). The spindle that should be selected is 'LCP/SP'.

12.1.2 Dismounting and cleaning

- Unscrew the spindle of the viscometer axis and lower the spindle slowly in the sample container (K).

Caution on removing the spindle, it can be hot due to a previous high temperature experiment.

- Remove the adapter (G) from the metallic glass.
- Place the viscometer upright. Remove the upper stopper (N).
- Remove the spindle carefully (L).
- Unscrew the bottom stopper (M) and remove the container (K) from below the thermo station jacket (J).
- Remove the container, wash it or use compressed air. Wash the circulation jacket too if necessary.
- Remove Adapter (G) from the circulation jacket.

Important:
Do not use any cleaner or tool that can damage the metallic surface. Make sure you only use liquids that agree with the LCP adapter material!

Solvents that can be used: water, ethanol or high concentrations of alcohol. For other solvents, check the chemistry compatibility table.

12.1.3 Technical specification for LCP accessories

Measurements rank:

- Sample L: 0.9* until 2 000 mPa.s or cP
- Sample R: 3.2** until 21 333 mPa.s or cP

* Limited by turbulences
** For the measurements that represent 10 % of the base scale

Sample volume: 16.0 ml

Shear rate factor for the LCP spindle: 1.2236 x RPM ***

*** Shear rate is calculated based on the features of Newtonian liquids.

Temperature rank of the circulation jacket & thermo station conditions:

- Temperature rank allowed: -10 a +100°C (14 a 212 °F)
- Use a thermo station wash with demineralised water or special refrigeration liquid. Change thermostat liquid regularly. Recommended flow: 15 l/min.

Materials:

- The metallic parts are made of stainless steel; the leads are made of black delrin plastic. The parts that come into contact with the sample (sample container and spindle) are made of AISI 316 and are suitable for the food industry.
- The lead inferior washer is made with black delrin. It is designed to withstand a maximum temperature of 100ºC (212 ºF)
- The circulation jacket is made of acetyl and Delrin.
- The O-ring on the plastic stopper (M) of the LCP Adapter is made of delrin.
  The softening point is 110 °C (230 °F).

12. 2. Small sample adapters APM and APM/B

NOTE:
Small sample adapters (APM and APM/B) are not included in the standard delivery. Any of these two versions (with or without thermostatic flow jacket) must be ordered as an additional accessory. APM and APM/B accessory are not supplied with a spindle. Special spindles (TL or TR) are used according to the viscometer model (L, R or H).

Small sample adapters allow more precise measurements than the standard spindles and reaching lower viscosity ranges.

Thanks to its known cylindrical geometry, it is possible to obtain Shear Rate and Shear Stress determinations. Only a small quantity of the sample is required.

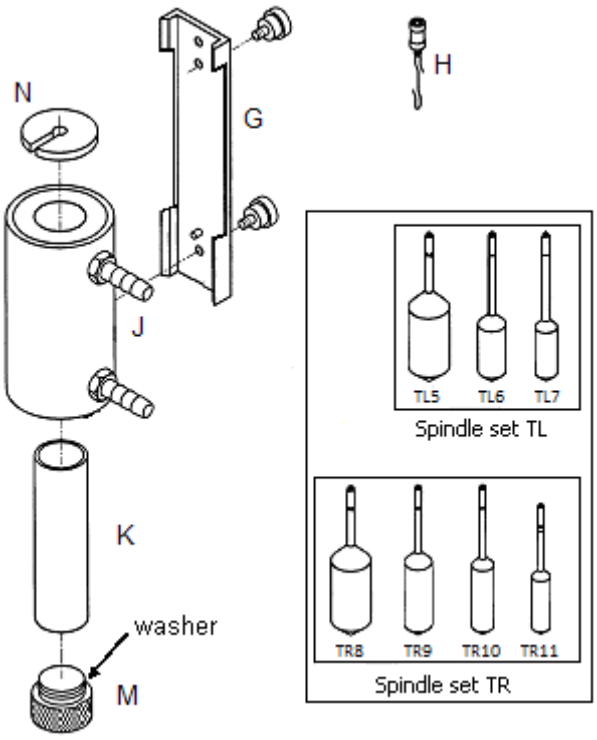


Fig. 12 APM accessory parts

Fig. 13 Set APM

12. 2. 1 Assembly

NOTE:

The mounting process is different according to the types of low viscosity accessories (APM and APM/B). The difference between them only remains in that the APM has a thermostatic flow jacket (J) and a container (K) and the APM/B only incorporates a container (K). The APM screw its thermostatic flow jacket (J) to the connector (G), on the other hand, the APM/B screws the container directly to the connector (G). The APM assembly process is detailed below:

- Unplug the viscometer.
- Close the sample (K) container with the stopper (M).
- Insert the container (K) to the lower part, in the circulation jacket (J) by turning it gently.
- Fasten the circulation jacket (J) to the connector (G)
- Fill the sample container with a 20 ml syringe or less and fill the sample container according to the spindle selected (see section 10.2.3).
- Connect the hook (H) and the spindle (L)
- Insert the spindle (L) in the circulation jacket (See the note * below)
- Fasten the connector (G) to the hole in the back of the viscometer's metallic base **(See the note ** below)**
- Screw it with the viscometer axle by turning it clockwise.
- Check the level of the sample. It should be approximately in the middle of the cone, which is connected to the spindle connector (H). Figure 13 shows more information about this.
- Place the upper stopper (N) over the sample container.

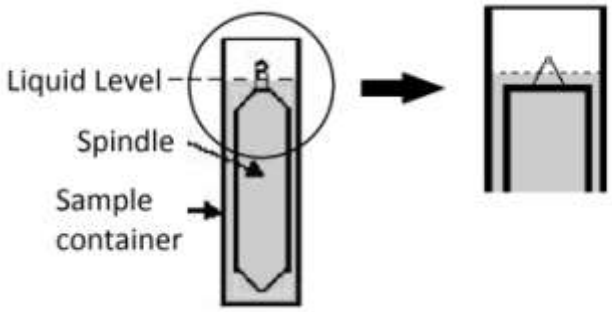


Fig. 13: Full APM adapter.

***Important:**

Do this slowly since the spindle must be inserted correctly in the sample. When working with a more viscous sample be careful to avoid pulling the spindle upwards. Hold the spindle connector.

****Important:**

The piece named G has two possible holes for the upper screw.
The top hole is a Universal hole to screw our small sample adapter to other brands viscometer.
The bottom hole is to screw Fungilab pieces.

NOTE:
Before starting with the measurements, make sure the viscometer is correctly balanced (check it with the bubble level). The Spindle selected shall be TL or TR in function of the model of viscometer (L. R or H).

12. 2. 2 Dismounting and cleaning

- Unscrew the spindle of the viscometer axis and lower the spindle slowly in the sample container (K).

Caution on removing the spindle, it can be hot due to a previous high temperature experiment.

- Remove Adapter (G) from metallic glass.
- Place the viscometer upright. Remove the upper stopper (N).
- Remove the spindle carefully (L).
- Unscrew the bottom stopper (M) and remove the container (K) from below the thermostatic flow jacket (J).
- Remove the container, wash it or use compressed air. Wash the circulation jacket too if necessary.
- Remove Adapter (G) from the circulation jacket.

Important:
Do not use any cleaner or tool that can damage the metallic surface. Make sure you only use liquids that agree with the APM adapter material!

Solvents that can be used: water, ethanol or high concentrations of alcohol. For other solvents, check the chemistry compatibility table.

12. 2. 3 Technical specifications of APM and APM/B

Measurement range:

- Model L: 1.5* to 200 000 mPa.s
- Model R: 25* to 3 300 000 mPa.s
- Model H: 0.2* to 26 660 Pa.s

* Measurement representing 10 % of the full scale.

Spindles features and APM filling:

- L Model & TL spindles

Spindle	Shear rate [s^{-1}] *)	Sample volume [ml]	Container
TL5	1.32 x RPM	6.7	STC
TL6	0.34 x RPM	9.0	STC
TL7	0.28 x RPM	9.4	STC
TL8	0.29 x RPM	4.2	TL8C
TL9	0.22 x RPM	16.0	STC

- R Model or H & TR spindles

Spindle	Shear rate [s^{-1}] *)	Sample volume [ml]	Container
TR8	0.93 x RPM	7.1	STC
TR9	0.34 x RPM	10.4	STC
TR10	0.28 x RPM	11.0	STC
TR11	0.25 x RPM	13.5	STC
TR12	0.48 x RPM	3.8	TR12C
TR13	0.40 x RPM	2.1	TR13C

*) Shear rate is calculated based on the features of Newtonian liquids.

Container	Stopper	D [mm]	L [mm]
TL8C	T8BC	13.03	27.57
TR13C	T13BC	12.7	42.7
TR12C	T12BC	12.7	22.9
STC	STBC	19.05	7

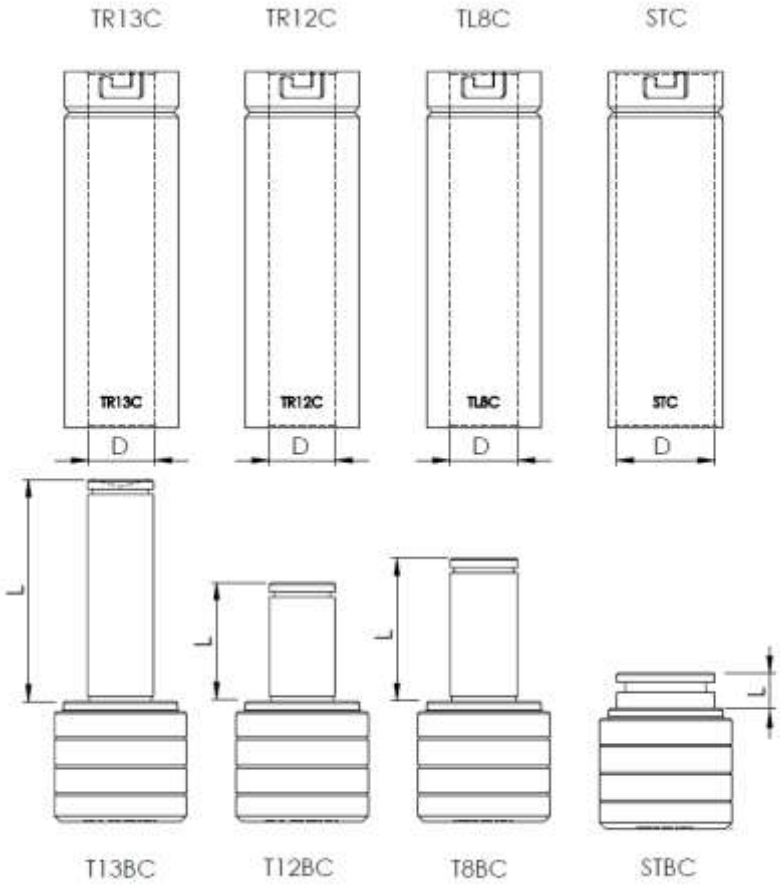


Fig. 14 Container dimensions

Temperature range of circulation jacket and thermostatic flow conditions:

- Permitted temperature range: -10 a +100°C (14 a 212 °F)
- Use a thermostatic bath with demineralised water or refrigeration special liquid. Change the liquid from the thermostatic bath regularly. Recommended flow: 15 l/min.

Materials:

- The metallic parts are made of stainless steel; the lids are made of Delrin plastic. The parts in contact with the sample (sample container and spindle) are made of AISI 316 suitable for food industry.
- The lid inferior washer is made in black Delrin. It is designed to get a maximum temperature of 100ºC (212 ºF)
- The circulation jacket is made of acetal and Delrin.
- The O-ring on the plastic stopper (M) of the APM Adapter is made of Delrin.
  The softening point is 110 °C (230 °F).

12.3 HELDAL UNIT – Helicoidal Movement Unit

NOTE:
The Heldal adapter doesn't come with the standard delivery. It can be ordered as an accessory. The unit is completely supplied with T-shaped spindles, in this case.

The Heldal accessory is used with substances that do not flow by themselves (like ice or pastas). The engine moves the viscometer slowly in a vertical movement and at the same time the spindle makes the rotation movement. This generates a helicoidal movement that makes that the T-shaped spindle is always in contact with the sample.
The measurements obtained with Heldal do not measure absolute viscosity! They are only comparative measurements with the same geometry as T-shaped spindles.

Fig. 15 Heldal Unit in its case

12.3.1 Heldal unit mounting

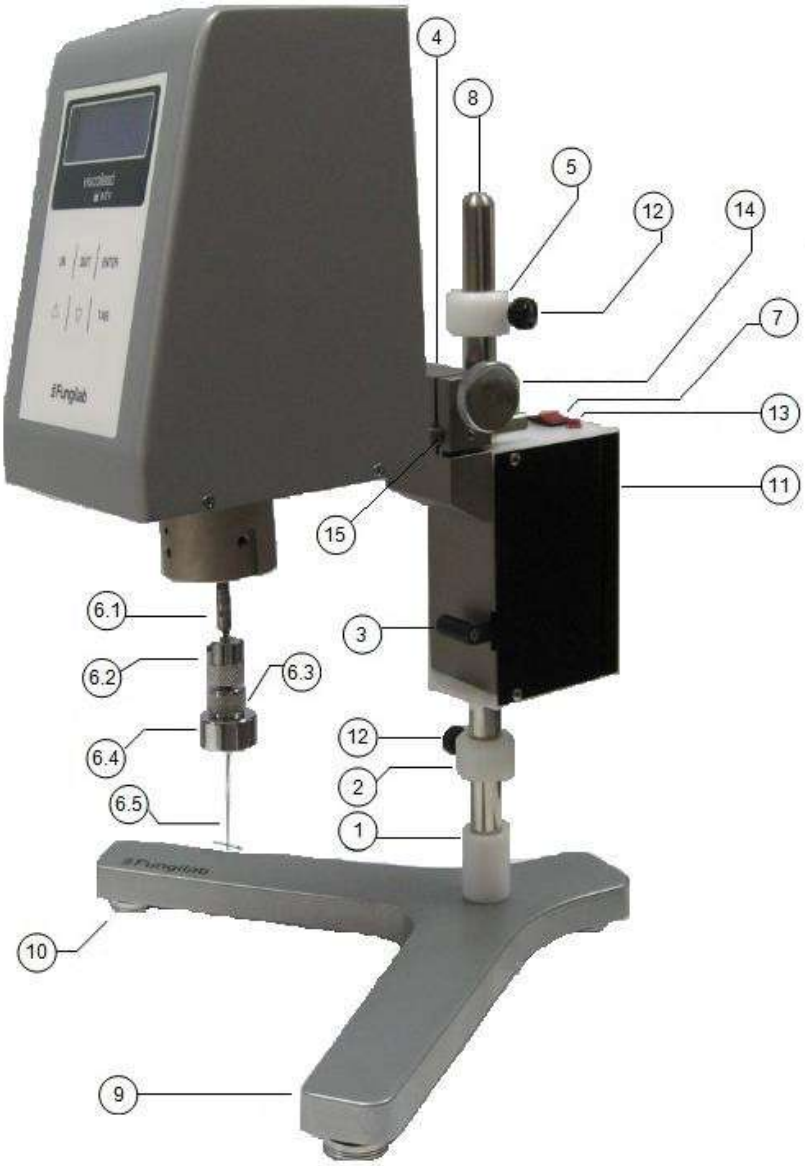


Fig. 16 Heldal unit set in the viscometer

1. Rib joint	9. Base
2. Lower stop ring	10. Levelling knobs
3. Displacement command	11. Heldal engine unit
4. Viscometer fastening bolt	12. Knobbed fastening rib
5. Upper stopper ring	13. Functioning pilot
6. Heldal fastening group	14. Nut bolt
7. ON/OFF switch	15. Viscometer fastening rib
8. Fastener	

6.1 Spindle connector
6.2 Upper spindle receptor
6.3 Lower spindle receptor
6.4 Counterweight, spindle connector
6.5 Spindle

- Place the fastener (8) facing the short end of the Y-shaped base (9).
- Place the safety shell (1) over the fastening rib (8) on the base of the viscometer (9).
- Place the lower ring in the fastener (8) as explained in the sketch and fasten it with the knobbed fastening rib (12).

Important:
Do not fasten the stop rings to the fastening ribs (12) too tightly. They are plastic pieces and they can be damaged. Both stopper rings (upper and lower) look exactly the same and can be changed.

- Place the Heldal engine (11) in the fastener (8) while pressing the displacement command (3).
- Connect the upper stop ring to the fastener (8) and fasten it with the fastening rib (12).
- Insert the viscometer by placing the fastening rib (15) in the Heldel bolt (4) and fasten it with the nut bolt (14).
- Balance the viscometer – Heldal set with the balancing knobs (10).
- Fasten the T-shaped spindle (PA to PF samples) to the viscometer. In order to choose the right one, look at the selection tables (T.3).

  - Screw the counterweight (6.4) in the lower part of the spindle receptor (6.3).
  - Insert the spindle receptor (6.5) between both upper and lower parts of the spindle receptor (6.2 and 6.3). Do not separate these two parts.
  - Fasten the spindle and screw in the lower part of the receptor (6.3) until it is completely fastened.

Important:
Do not fasten the spindle tighter than necessary. There should always be a small hole between both parts of the receptor.

- Fasten the spindle receptor and the spindle to the axis of the viscometer, by connecting the thread.
- Place the sample container under the viscometer and insert the spindle into the sample fluid by pressing the displacement button (3).
- The stopper rings limit the vertical movement of the spindle. Therefore, these two rings must be fastened correctly and in their correct positions.

Important:
Placement of stopper rings as explained here:

- Upper ring: the spindle should be kept in the same fluid
- Lower stopper ring: The spindle must not touch the edge of the container. If so, the viscometer's axle can be damaged and the results can be wrong.
- Once the rings are fastened, connect the viscometer and the Heldal to the power point. Switch the viscometer on and insert the speed and the spindle, as always.
- Set the Heldal unit on with the ON/OFF switch (7). Check if the pilot is on. If not, check the main connection.

OPERATION:
The Heldal unit (which moves helicoidally) is moved up and down between the two stopper rings.
When the engine touches one of them, the unit changes direction.
The Heldal unit will keep moving, until turned off with the ON/OFF switch (7).

12.4. Thermosphere

The Thermosphere is a heating chamber used to work with different samples at high temperatures, it allows to perform different tests with a controlled temperature. The thermosphere works in standalone mode, but it can be connected to the viscometer to send the temperature data to the viscometer screen.

The Thermosphere is not included in the standard delivery. It must be ordered as an additional accessory.

Fig. 17 Viscometer with Thermosphere unit

12.4.1 Connecting Thermosphere to viscometer

To communicate the Thermosphere with the viscometer it is only needed to connect the USB cable in the USB port dedicated to that function (fig 18.). When the Thermosphere is turned on it will automatically connect with the viscometer. The temperature value will appear on the measuring screen when the viscometer initiates an experiment.

Fig. 18 Thermosphere connection

13. Model/Spindle correspondence tables

Standard Spindles + R1 (Table 1):

Viscometer model	Spindle
ADVANCE L	L1
	L2
	L3
	L4
	L5
ADVANCE R	R1
	R2
	R3
	R4
	R5
	R6
	R7
ADVANCE H	R1
	R2
	R3
	R4
	R5
	R6
	R7

SPECIAL SPINDLES FOR APM ADAPTER (Table 2):

Viscometer model	Spindle
ADVANCE L	L2C
	L3C
	TL5
	TL6
	TL7
	TL8
	TL9
ADVANCE R	TR8
	TR9
	TR10
	TR11
	TR12
	TR13
ADVANCE H	TR8
	TR9
	TR10
	TR11
	TR12
	TR13

SPECIAL HELDAL SPINDLES (Table 3):

Viscometer model	Spindle
ADVANCE L	PA
	PB
	PC
	PD
	PE
	PF
ADVANCE R	PA
	PB
	PC
	PD
	PE
	PF
ADVANCE H	PA
	PB
	PC
	PD
	PE
	PF

SPECIAL SPINDLES FOR LCP ADAPTER (Table 4):

Viscometer model	Spindle
ADVANCE L	LCP/SP
ADVANCE R	LCP/SP

SPECIAL VANE SPINDLES (Table 5):

Viscometer model	Spindle
ADVANCE L	V71
	V72
	V73
	V74
	V75
ADVANCE R	V71
	V72
	V73
	V74
	V75
ADVANCE H	V71
	V72
	V73
	V74
	V75

14. Model/spindle/oil calibration tables

MODEL L (Table 6):

Spindle	Standard oil
L1	RT50
L2	RT500
L2C	RT500
L3	RT1000
L3C	RT1000
L4	RT5000
L5	RT12500
TL5	RT50
TL6	RT500
TL7	RT500
TL8	RT1000
TL9	RT5000
LCP	RT5

MODEL R (Table 7):

Spindle	Standard oil
R1	RT50
R2	RT500
R3	RT500
R4	RT1000
R5	RT5000
R6	RT5000
R7	RT30000
TR8	RT500
TR9	RT5000
TR10	RT5000
TR11	RT5000
TR12	RT5000
TR13	RT12500
LCP	RT50

MODEL H (Table 8):

Spindle	Standard oil
R1	RT1000
R2	RT5000
R3	RT12500
R4	RT12500
R5	RT30000
R6	RT100000
R7	RT100000
TR8	RT5000
TR9	RT12500
TR10	RT30000
TR11	RT60000
TR12	RT60000
TR13	RT60000

15. ADVANCE L standard spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	L1	L2	L3	L4	L5
0.3	20K	100K	400K	2M	4M
0.5	12K	60K	240K	1.2M	2.5M
0.6	10K	50K	200K	1M	2M
1	6K	30K	120K	600K	1.2M
1.5	4K	20K	80K	400K	800K
2	3K	15K	60K	300K	600K
2.5	2.4K	12K	48K	240K	500K
3	2K	10K	40K	200K	400K
4	1.5K	7.5K	30K	150K	300K
5	1.2K	6K	24K	120K	250K
6	1K	5K	20K	100K	200K
10	600	3K	12K	60K	125K
12	500	2.5K	10K	50K	100K
20	300	1.5K	6K	30K	60K
30	200	1K	4K	20K	40K
50	120	600	2.4K	12K	25K
60	100	500	2K	10K	20K
100	60	300	1.2K	6K	12K

Table 9.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

16. ADVANCE L Special aerial spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	L2C	L3C
0.3	100K	400K
0.5	60K	250K
0.6	50K	200K
1	30K	125K
1.5	20K	80K
2	15K	60K
2.5	12K	50K
3	10K	40K
4	7.5K	30K
5	6K	25K
6	5K	20K
10	3K	12K
12	2.5K	10K
20	1.5K	6K
30	1K	4K
50	600	2.5K
60	500	2K
100	300	1.2K

Table 10.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

17. ADVANCE L Special spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	TL5	TL6	TL7	TL8	TL9
0.3	10K	100K	200K	400K	1.6M
0.5	6K	60K	120K	240K	1M
0.6	5K	50K	100K	200K	800K
1	3K	30K	60K	100K	500K
1.5	2K	20K	40K	80K	330K
2	1.5K	15K	30K	60K	250K
2.5	1.2K	12K	24K	50K	200K
3	1K	10K	20K	40K	160K
4	750	7.5K	15K	30K	125K
5	600	6K	12K	25K	100K
6	500	5K	10K	20K	80K
10	300	3K	6K	12K	50K
12	250	2.5K	5K	10K	40K
20	150	1.5K	3K	6K	25K
30	100	1K	2K	4K	16K
50	60	600	1.2K	2.5K	10K
60	50	500	1K	2K	8K
100	30	300	600	1.2K	5K

Table 11.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

18. ADVANCE L LCP Adaptor table

Maximum guideline values in cP (mPa·s)

RPM/SP	LCP
0.3	2K
0.5	1.2K
0.6	1K
1	600
1.5	400
2	300
2.5	240
3	200
4	150
5	120
6	100
10	60
12	50
20	30
30	20
50	12
60	10
100	6.0

Table 12.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

19. ADVANCE L special Vane spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	V71	V72	V73	V74	V75
0.3	8.1K	34.6K	167K	1.6M	721K
0.5	4.9K	20.8K	100K	1M	433K
0.6	4K	17.3K	83.5K	848K	360K
1	2.4K	10.4K	50.1K	508K	216K
1.5	1.6K	6.93K	33.4K	339K	144K
2	1.2K	5.2K	25K	254K	108K
2.5	982.2	4.1K	20K	203K	86.6K
3	818.5	3.4K	16.7K	169K	72.1K
4	613.9	2.6K	12.5K	127K	54.1K
5	491.1	2k	10K	101K	43.3K
6	409.2	1.7K	8.3K	84.8K	36K
10	245.5	1K	5K	50.8K	21.6K
12	204.6	867	4.1K	42.4K	18K
20	122.7	520.2	2.5K	25.4K	10.8K
30	81.8	346.8	1.6K	16.9K	7.2K
50	49.1	208	1K	10.1K	4.3K
60	40.9	173.4	835.7	8.4K	3.6K
100	24.5	100	501.4	5K	2.1K

Table 13.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

20. ADVANCE L special Heldal spindle selection table

Maximum guideline values in cP (mPa·s)

RPM/SP	PA	PB	PC	PD	PE	PF
0.3	62.4K	124.8K	312K	624K	1.5M	3.1M
0.5	37.4K	74.8K	187K	374K	936K	1.8M
0.6	31.2K	62.4K	156K	312K	780K	1M
1	18.72K	37.4K	93.6K	187K	468K	936K
1.5	12.4K	24.9K	62.4K	124K	312K	624K
2	9.36K	18.7K	46.8K	93.6K	234K	468K
2.5	7.4K	14.9K	37.4K	74.8K	187K	374.4K
3	6.2K	12.4K	31.2K	62.4K	156K	312K
4	4.6K	9.3K	23.4K	46.8K	117K	234K
5	3.7K	7.4K	18.7K	37.4K	93.6K	187.2K
6	3.1K	6.2K	15.6K	31.2K	78K	156K
10	1.8K	3.7K	9.3K	18.7K	46.8K	93.6K
12	1.5K	3.12K	7.8K	15.6K	39K	78K

Table 14.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

21. ADVANCE R standard spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	R1	R2	R3	R4	R5	R6	R7
0.3	33.3K	133.3K	333.3K	666.6K	1.3M	3.33M	13.3M
0.5	20K	80K	200K	400K	800K	2M	8M
0.6	16.6K	66.6K	166.6K	333.3K	666.6K	1.6M	6.6M
1	10K	40K	100K	200K	400K	1M	4M
1.5	6.6K	26.6K	66.6K	133.3K	266.6K	666.6K	2.6M
2	5K	20K	50K	100K	200K	500K	2M
2.5	4K	16K	40K	80K	160K	400K	1.6M
3	3.3K	13.3K	33.3K	66.6K	133.3K	333.3K	1.3M
4	2.5K	10K	25K	50K	100K	250K	1M
5	2K	8K	20K	40K	80K	200K	800K
6	1.6K	6.6K	16.6K	33.3K	66.6K	166.6K	666.6K
10	1K	4K	10K	20K	40K	100K	400K
12	833	3.3K	8.3K	16.6K	33.3K	83.3K	333.3K
20	500	2K	5K	10K	20K	50K	200K
30	333	1.3K	3.3K	6.6K	13.3K	33.3K	133.3K
50	200	800	2K	4K	8K	20K	80K
60	166	660	1.6K	3.3K	6.6K	16.6K	66.6K
100	100	400	1K	2K	4K	10K	40K

Table 15.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

22. ADVANCE R Special spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	TR8	TR9	TR10	TR11	TR12	TR13
0.3	166.6K	833.3K	1.6M	3.3M	1.6M	4.1M
0.5	100K	500K	1M	2M	1M	2.5M
0.6	83.3K	416.6K	833.3K	1.6M	833.3K	2M
1	50K	250K	500K	1M	500K	1.2M
1.5	33.3K	166.6K	333.3K	666.6K	333.3K	833.3K
2	25K	125K	250K	500K	250K	625K
2.5	20K	100K	200K	400K	200K	500K
3	16.6K	83.3K	166.6K	333.3K	166.6K	416.6K
4	12.5K	62.5K	125K	250K	125K	312.5K
5	10K	50K	100K	200K	100K	250K
6	8.3K	41.6K	83.3K	166.6K	83.3K	208.3K
10	5K	25K	50K	100K	50K	125K
12	4.16K	20.83K	41.6K	83.3K	41.6K	104.1K
20	2.5K	12.5K	25K	50K	25K	62.5K
30	1.6K	8.3K	16.6K	33.3K	16.6K	41.6K
50	1K	5K	10K	20K	10K	25k
60	833.3	4.16K	8.3K	16.6K	8.3K	20.8k
100	500	2.5K	5K	10K	5K	12.5K

Table 16.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

23. ADVANCE R LCP Adaptor table

Maximum guideline values in cP (mPa·s)

RPM	LCP
0.3	21.3K
0.5	12.8K
0.6	10K
1	6.4K
1.5	4.2K
2	3.2K
2.5	2.5K
3	2.1K
4	1.6K
5	1.2K
6	1K
10	640
12	533
20	320
30	213
50	128
60	106
100	64

Table 17.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

24. ADVANCE R special Vane spindle selection table

Maximum guideline values in cP (mPa·s)

RPM / SP	V71	V72	V73	V74	V75
0.3	87.3K	370K	1.7M	18.1M	7.6M
0.5	52.3K	222K	1M	10.8M	4.6M
0.6	43.6K	185K	891K	9M	3.8M
1	26.1K	111K	535K	5.4M	2.3M
1.5	17.4K	74K	356K	3.6M	1.5M
2	13K	55.5K	267K	2.7M	1.1M
2.5	10.4K	44.4K	214K	2.1M	924K
3	8.7K	37K	178K	1.8M	770K
4	6.5K	27.7K	133K	1.3M	577K
5	5.2K	22.2K	107K	1M	462K
6	4.3K	18.5K	89.1K	905K	385K
10	2.6K	11.1K	53.5K	543K	231K
12	2.1K	9.2K	44.5K	452K	192K
20	1.3K	5.5K	26.7K	271K	115K
30	873.3	3.7K	17.8K	181K	77K
50	524	2.2K	10.7K	108K	46.2K
60	436.6	1.8K	8.91K	90.5K	38.5K
100	262	1.1K	5.3K	54.3K	23.1K

Table 18.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

25. ADVANCE R special Heldal spindle selection table

Maximum guideline values in cP (mPa·s)

RPM/SP	PA	PB	PC	PD	PE	PF
0.3	666.6K	1.3M	3.3M	6.6M	16.6M	33.3M
0.5	400K	800K	2M	4M	10M	20M
0.6	333.3K	666.6K	1.6M	3.3M	8.3M	16.6M
1	200K	400K	1M	2M	5M	10M
1.5	133.3K	266.6K	666.6K	1.3M	3.3M	6.6M
2	100K	200K	500K	1M	2.5M	5M
2.5	80K	160K	400K	800K	2M	4M
3	66.6K	133.3K	333.3K	666.6K	1.6M	3.3M
4	50K	100K	250K	500K	1.25M	2.5M
5	40K	80K	200K	400K	1M	2M
6	33.3K	66.6K	166.6K	333.3K	833.3K	1.6M
10	20K	40K	100K	200K	500K	1M
12	16.6K	33.3K	83.3K	166.6K	416.6K	833.2K

Table 19.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

26. ADVANCE H standard spindle selection table

Maximum guideline values in Poise

RPM/SP	R1	R2	R3	R4	R5	R6	R7
0.3	2.6K	10.6K	26.6K	53.3K	106.6K	266.6K	1M
0.5	1.6K	6.4K	16K	32K	64K	160K	640K
0.6	1.3K	5.3K	13.3K	26.6K	53.3K	133.3K	533.3K
1	800	3.2K	8K	16K	32K	80K	320K
1.5	533.3	2133	5.3K	10.6K	21.3K	53.3K	213.3K
2	400	1.6K	4K	8K	16K	40K	160K
2.5	320	1.28K	3.2K	6.4K	12.8K	32K	128K
3	266.6	1066	2.6K	5.3K	10.6K	26.6K	106.6K
4	200	800	2K	4K	8K	20K	80K
5	160	640	1.6K	3.2K	6.4K	16K	64K
6	133.3	533.3	1.3K	2.6K	5.3K	13.3K	53.3K
10	80	320	800	1.6K	3.2K	8K	32K
12	66.6	266.6	666	1.3K	2.6K	6.6K	26.6K
20	40	160	400	800	1.6K	4K	16K
30	26.6	106.6	266	533	1066	2.6K	10.6K
50	16	64	160	320	640	1.6K	6.4K
60	13.3	53.3	133.3	266.6	533	1.3K	5.3K
100	8	32	80	160	320	800	3.2K

Table 20.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

27. ADVANCE H Special spindle selection table

Maximum guideline values in Poise

RPM / SP	TR8	TR9	TR10	TR11	TR12	TR13
0.3	13.6K	66.6K	133.3K	266.6K	133.3K	333.3K
0.5	8K	40K	80K	160k	80K	200K
0.6	6.6K	33.3K	66.6K	133.3K	66.6K	166.6K
1	4K	20K	40K	80K	40K	100K
1.5	2.6K	13.3K	26.6K	53.3K	26.6K	66.6K
2	2K	10K	20K	40K	20K	50K
2.5	1.6K	8K	16K	32K	16K	40K
3	1.3K	6.6K	13.3K	26.6K	13.3K	33.3K
4	1K	5K	10K	20K	10K	25K
5	800	4K	8K	16K	8K	20K
6	666	3.30K	6.6K	13.3K	6.6K	16.6K
10	400	2K	4K	8K	4K	10K
12	333	1.6	3.3K	6.6K	3.3K	8.3K
20	200	1K	2K	4K	2K	5K
30	133	666	1.3K	2.6K	1.3K	3.3K
50	80	400	800	1.6K	800	2K
60	66	333	666	1.3K	666	1.6K
100	40	200	400	800	400	1K

Table 21.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

28. ADVANCE H special Vane spindle selection table

Maximum guideline values in poise

RPM / SP	V71	V72	V73	V74	V75
0.3	6.9K	29.6K	142K	1.4M	615K
0.5	4.1K	17.7K	85.6K	868K	369K
0.6	3.4K	14.8K	71.3K	724K	307K
1	2K	8.8K	42.8K	434K	184K
1.5	1.3K	5.9K	28.5K	289K	123K
2	1K	4.4K	21.4K	217K	92.4K
2.5	838	3.5K	17.1K	173K	73.9K
3	698	2.9K	14.2K	144K	61.6K
4	523	2.2K	10.7K	108K	46.2K
5	419	1.7K	8.5K	86.8K	36.9K
6	349	1.4K	7.1K	72.4K	30.8K
10	209	888	4.2K	43.4K	18.4K
12	174	740	3.5K	36.2K	15.4K
20	104	444	2.1K	21.7K	9.24K
30	69.8	296	1.4K	14.4K	6.1K
50	41.9	177	856	8.6K	3.6K
60	34.9	148	713	7.2K	3K
100	20.9	88.8	428	4.3K	1.8K

Table 22.

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

29. ADVANCE H special Heldal spindle selection table

Maximum guideline values in Poise

RPM/SP	PA	PB	PC	PD	PE	PF
0.3	53.3K	106K	266.6K	533.3K	1.3M	2.6M
0.5	32K	64K	160K	320K	800K	1.6M
0.6	26.6K	53.3K	133.3K	266.6K	666.6K	1.3M
1	16K	32K	80K	160K	400K	800K
1.5	10.6K	21.3K	53.3K	106K	266.6K	533.3K
2	8K	16K	40K	80K	200K	400K
2.5	6.4K	12.8K	32K	64K	160K	380K
3	5.3K	10.6K	26.6K	53.3K	133.3K	266.6K
4	4K	8K	20K	40K	100K	200K
5	3.2K	6.4K	16K	32K	80K	160K
6	2.6K	5.3K	13.3K	26.6K	66.6K	133.3K
10	1.6K	3.2K	8K	16K	40K	80K
12	1.3K	2.6K	6.6K	13.3K	33.3K	66.6K

Table 23

ATTENTION:

K Indicates thousands. Example: 7.8K = 7800
M Indicates millions Example: 1.56M = 1560000

NOTE: It is not recommended to work with viscosity values of less than 15% of the lower part of the selected scale.

WARRANTY CERTIFICATE

FUNGILAB S.A. guarantee the perfect functioning of this instrument against defects in material or workmanship, when used under appropriate conditions and in accordance with the operation instructions for a period of **TWO YEARS** from the invoice date of the product.

The following cases cancel the warranty period:

- Misuse of the instruments
- When the equipment has been damaged by the user
- When the user has not had in mind the Fungilab recommendations and maintenance.
- When the instrument has been repaired or mishandled by anybody not allowed for the Fungilab technical service.
- When the serial number is incorrect or it does not suit with the written in the warranty.

FUNGILAB's sole obligation shall be to repair or to replace any part(s) that prove defective within the warranty period and shall not be liable for consequential damages resulting from the use of its products.

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